A STUDY TO COMPARE THE FAILURE RATES OF CURRENT SPACE SHUTTLE GROUND SUPPORT EQUIPMENT WITH THE NEW PATHFINDER EQUIPMENT AND INVESTIGATE THE EFFECT THAT THE PROPOSED GSE INFRASTRUCTURE UPGRADE MIGHT HAVE TO REDUCE GSE INFRASTRUCTURE FAILURES

by

Barbara J. Kennedy

A Graduate Research Project
Submitted to the Extended Campus
In Partial Fulfillment of the Requirements of the Degree of
Master of Aeronautical Science

Embry-Riddle Aeronautical University
Extended Campus
Space Coast Resident Center
November 22, 2004

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This graduate research project was prepared under the direction of the candidate's Research Committee Member, Dr. Anthony J. Delmonte, Adjunct Associate Professor, Extended Campus, and the candidate's Research Committee Chair, Dr. Charlie Joe Allen, Associate Professor, Extended Campus, and has been approved by the Project Review Committee. It was submitted to the extended Campus in partial fulfillment of the requirements for the degree of Masters of Aeronautical Science

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where language of others is set forth, quotations marks so indicate, and that the appropriate credit is given where I have used the language, ideas, or writings of others.

Barbara J. Kennedy

August 2004

ACKNOWLEDGEMENTS

The writer wishes to express special thanks to Dr. Charlie Joe Allen for all his guidance and direction during the preparation of the proposal for this project. Without his vast knowledge of research methodology and statistics, this study would not have been possible.

Special thanks are also extended to Dr. Tony Delmonte, committee member and Dr. Charlie Joe Allen, my GRP chair for this project. Special thanks to Professor Jack Wrinkle for the words of encouragement throughout my study in the ERAU aeronautical science curriculum.

Sincere thanks and appreciation is given to the "INCS's guys", Neil Mizell, Robert Brown, Wayne McClellan and Quentin Campbell.

Lastly, not to be over-looked, is the person that took me for my first airplane ride in 1994, Mr. Ralph Garner. His mentoring and patience during private pilot training gave me inspiration and knowledge of my ability to fly airplanes. In addition, the knowledge that I could attend and graduate from an aeronautical college with a Master in Aeronautical Science grew as well. Ralph was truly an inspiration to me. Without that introduction to flight and completion of my pilot's license, this MAS degree and the GRP project would not have been attainable. With my knowledge, I will mentor others about flight.

ABSTRACT

Writer: Barbara J. Kennedy

Title: A study to compare the failure rates of current Space Shuttle Ground Support Equipment with the new Pathfinder equipment and investigate the effect that the proposed GSE infrastructure upgrade might have to reduce GSE infrastructure failures.

Institution: Embry-Riddle Aeronautical University

Degree: Master Aeronautical Science

Year: 2004

The purposes of this study are to compare the current Space Shuttle GSE infrastructure with the proposed GSE infrastructure upgrade modification. The methodology will include analyzing the first prototype installation equipment at Launch PAD B called the "Pathfinder". This study will begin by comparing the failure rate of the current ground components associated with the "Hardware interface module (HIM)" at the Kennedy Space Center to the failure rate of the new Pathfinder components. Quantitative data will be gathered specifically on HIM components and the PAD B Hypergolic Fuel facility and Hypergolic Oxidizer facility areas which has the upgraded pathfinder equipment installed. The proposed upgrades include utilizing industrial controlled modules, software, and a fiber optic network. The results of this study provide evidence that there is a significant difference in the failure rates of the two studied infrastructure

equipment components. There is also evidence that the support staff for each infrastructure system is not equal. A recommendation to continue with future upgrades is based on a significant reduction of failures in the newly installed ground system components.

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CHAPTER I

INTRODUCTION

The Space Shuttle Operations Contract is the governing document over the operations and maintenance of all Shuttle processing and associated ground equipment.

Background History of LC-39

Launch Complex 39 was originally designated the Launch Operations Center (LOC) and also known as Kennedy Space Center. It was built in 1962 to support the Apollo program. The infrastructure was enormous and contained cabling, relays, power supplies, and communication equipment.

Indicators were installed to give remote visibility to the engineering staff that launched the rocket. The LC-39 Complex introduced the mobile concept of launch. NASA had previously used the fixed launch concept at Cape Kennedy and other launch sites. Fixed launch method called for assembly, checkout, and launch of the rocket at one site at the launch Pad. This system not only tied up the launch Pad, but also exposed flight equipment to the influences of weather.

The mobile concept allows the space vehicle to be assembled and checked out before it is moved to the launch Pad for final preparations and launch. The benefits of this mobile launch processing include: greater protection of Space vehicle, more systematic checkout process, and a higher launch rate for the future, due to vehicle "on Pad time" being minimal per vehicle and per flow.

The major components of LC39 include: the Vehicle Assembly Building (VAB), the Launch Control Center (LCC), the Mobile Launcher Platform (MLP), the Mobile Service Structure, the Transporter, the Crawler Way, and the Launch Pads.

The Launch Control Center is the electronic "brain" of Launch Complex 39. The LCC is the location where engineers perform Shuttle and Ground Support Equipment (GSE) testing. Commanding and monitoring are performed through the use of computerized consoles. Vehicle and GSE checkout, as well as launch operations, are repetitively completed each flow by utilizing the display monitors and control equipment.

The LCC contains four firing rooms. Three of the firing rooms are equipped with identical sets of control and monitoring equipment.
In total, the firing rooms have some 450 consoles. During the Apollo program, the information that was received at the consoles was limited to lights and gauges. Today there are grouped sets of hardware and software clusters to bring organization to the testing and how it can be completed somewhat efficiently.

In the years following the 1962 construction of LC-39, the Ground Support Equipment consisted of hardwired switches and relays. Then, NASA started gearing up for the Space Transportation System (STS) Space Shuttle. During this new program shift, engineers designed a new launch control system away from the traditional hardwire system. The new system was a processor based control system with field controllers to take analog and discrete voltages and

incorporate them into a digital data stream. The firing room and GSE checkout is now named Checkout, Control, and Monitor System (CCMS). At the completion of the modification in the 1970's, it was considered "state of the art in centralized control systems." The CCMS system still serves the Shuttle program today in year 2004 with very few modifications. (Bodziak, Brown, Meilbye, & Kimmons (2002).

Current Infrastructure Technology

The current control system, including the CCMS equipment, are all wrapped up into a term used by the LC-39 community called the Launch Processing System (LPS). LPS consists of consoles in the firing rooms, Front End Processors (FEP), Fiber Optic Terminal Equipment (FOTE), Hardware Interface Modules (HIMs), and Ground Support Equipment (GSE)

The GSE consists of the actual components in the field (end items), component cables, control distributors, bulkhead plates, terminal distributors, patch racks, relays modules, diode modules, fuse panels, receptacle distributors, and miles of cable to connect all the items together.

A misconception that many people have when they see the launch team in the firing room on launch day is that the ground control system is state of the art. Actually, the LPS portion of the ground system, which is the newest part of the system, was designed and built in the 1970's. Although some components have been updated, they still retain a near obsolete architecture. The remaining parts of the ground system - - the patch racks, terminal distributors, and control distributors are the same hardware infrastructure which was used in the Apollo

program. This hardware remains in place on the same launch Pads and the still existing mobile launcher platforms today. During the Apollo program, a point-to-point architecture was used which extremely limited the expandability and is totally based on specifications that are not supported anywhere in the world except at KSC. (Bodziak, Brown, Meilbye, & Kimmons)

INCS proposed Infrastructure Upgrade Technology

A newly proposed GSE infrastructure upgrade was presented to KSC engineering and management in July 2000. This project was called the Integrated Network Control System (INCS). A prototype was needed for a proof of concept. Instead of a prototype, a pathfinder was used. The launch Pad B was the site selected but only the Hypergolic Fuel and Oxidizer Farms and supporting infrastructure was targeted for the first installation. When this pathfinder temporary infrastructure was installed at the PAD B farms, it purposely did not demolish the current infrastructure network and supporting equipment so it could be retrofitted back if the project manager did not approve of the performance. The details of the new infrastructure and performance of the Pad B Pathfinder will be analyzed in this GRP.

The theory behind INCS future installation sites is to replace the current ground command and measurement system with a new GSE command and control system. Not only will it be used for the shuttle program, but can also be used on future programs after Shuttle is retired. The INCS's entire infrastructure is based on programmable logic controllers (PLC) and real-time network

communication busses. The equipment is based on "industry standards" and is using industry proven technology. This will simplify the ground control system by changing the total architecture of KSC ground launch control system by enabling the use of COTS parts and intelligent end items. (Bodziak, Brown, Meilbye, & Kimmons)

The Importance of this study

This study has the potential to estimate the failure rate on present GSE infrastructure equipment. This study will compare the failure rates of the old GSE infrastructure and the newly proposed infrastructure. This study will attempt to estimate required support personnel on the old and new systems. This study will support or not support a decision to continue with future upgrades of the GSE.

Statement of the Problem

The purpose of this study is to compare the current Space Shuttle GSE infrastructure with the proposed GSE infrastructure upgrade by analyzing the first pathfinder installation at Launch Pad B in order to assess the effectiveness of the new system.

Sub problems

The first sub problem – Estimate the failure rate of the old GSE infrastructure components.

The second sub problem – Estimate the failure rate of the new industrial based technology components used in the INCS Pathfinder infrastructure upgrades.

The third sub problem – Compare the failure rate of the old GSE infrastructure components and the failure rate of the Pathfinder components.

The fourth sub problem – Compare the number of support personnel in the HIM infrastructure with the number of support personnel in the Pathfinder infrastructure.

Assumptions

A valid method of measurement exists with which to estimate the failure rate on GSE.

The problem reporting (PR) database called Maximo is a valid and reliable instrument used for data gathering on recent problems within the LPS HIM failures.

Input to the Maximo database for problem reporting documentation is accurate.

The problem reporting (PR) database called Adam Warehouse's WebPcass is a valid and reliable instrument used for data gathering on recent problems within the hypergolic GSE Pathfinder failures.

Input to the ADAM data warehouse for problem reporting documentation is accurate.

Delimitations

This study will only evaluate the current GSE HIM infrastructure at Kennedy Space Center and the INCS Pathfinder GSE components at Launch

Pad B.

This study is only inclusive of the Space Shuttle ground Hypergolic Fuel and Oxidizer Systems for the Pathfinder data and will not include the Hypergolic systems on the Space Shuttle vehicle itself.

This study will not include other ground systems at the stated locations, since currently, there are no installations to make a comparison with.

This study will not include other locations such as the VAB, OPF hangers, HMF, nor SSPF for the Pathfinder infrastructure, however, the HIM infrastructure includes all HIM installation locations. This is due to the availability of data.

Only the study of GSE failures stated in the problem statement will be examined.

This study will not include technical equipment outside the aerospace processing and launch departments.

This is a restricted study. Dissemination of results to persons outside the company will be limited to the researcher's GRP committee member, GRP Chair, and the ERAU Space Coast Center Director only.

This study will estimate the required support personnel needed to staff the Pad A, Pad B, and LCC GSE infrastructure but will not provide USA organizational chart structure and staffing proprietary information.

This study will find historical annual failure rates but will not address or estimate future failure rates.

This study will not attempt to fault any person or organization as a result of the findings.

Definition of Terms

The Ground Support Equipment (GSE) refers to equipment that is necessary to support Shuttle processing and readiness for the next flight. This equipment is based on the ground or similar ground structures. It is not on the space shuttle vehicle.

Abbreviations

ATM - Asynchronous Transfer Mode

ATXS - ATM Transmission System

CCMS - Checkout, Control, and Monitor System

CCS - Complex Control System

CLCS - Checkout and Launch Control System

COTS - Commercial Off The Shelf

ESA - Engineering Support Area

FEP - Front End Processor

FOTE - Fiber Optic Terminal Equipment

FTM - Fiber Terminal Module

GSE - Ground Support Equipment

HIM - Hardware Interface Module

HMI - Human Machine Interface

HMN - Health Monitor Network

HPO - High Performance Organization

IMT - Instrumentation Modernization Team

INCS - Integrated Network Control System

KCCS - Kennedy Complex Control System

KSC - Kennedy Space Center

LAN - Local Area Network

LCC - Launch Control Center

LOC - Launch Operation Center

LLO - Launch and Landing Operations

LPS - Launch Processing System

MDF - Main Distribution Frame

NASA - National Aeronautics and Space Administration

OLE - Object Linking and Embedding

OO - Obiter Operations

OPC - OLE for Process Control

PLC - Programmable Logic Controller

PR – Problem Report

SCADA - Supervisory Control and Data Acquisition

STS - Space Transportation System

USA - United Space Alliance

USAGO - United Space Alliance Ground Operations

WBS - Work Breakdown Structure

CHAPTER II

REVIEW OF LITERATURE

What is the old GSE Infrastructure?

Most of the current LC-39 GSE infrastructure consist of 1960's technology that supported the launches of the Apollo era with the exception of a few 10-year-old enhancements.

The interface to the GSE end items were from the Firing Room patch panel, through signal condition equipment (SCE) devices which matched the electrical characteristics of signals going between ground lines and orbiter lines. There are also patch panels for routing the signals. The patching, SCE, and miles of cabling to the field connected to a general-purpose interface rack called a HIM (Hardware Interface Module). This HIM is located near the facility GSE end item to allow remote command and monitoring of the GSE in the field via input and output functions (I/O). The HIM signaled the GSE end item for movement, and then gathered measurements to send up to the LCC to be processed by the Front End Processor (FEP). The link that allows the HIMs to continue interfacing with the FEP is called a Ground Data Bus (GDB). The HIM could contain up to 30 I/O cards each with it's own unique addressing for commands and measurements. HIMs are usually single bays of equipment containing the selected cards that would properly perform the needed functions. The cards were mostly analog-to digital (A/D), digital-to-analog (D/A) and discrete I/O cards. The I/O cards contain four to sixteen I/O paths that, with only a few exceptions, are connected to GSE transducers or actuators. Usually eight HIMs are

connected to each ground data bus (GDB). In the majority of the LCC operations, the HIMs were commanded and polled for data by the FEP; however, some HIMs were equipped with an interface to a local processor that serves a function similar to a LCC console. The console associated with the Local Programmable Control (LPC) HIMs can initiate software programs independent of the firing rooms. LPC HIMs are often called "Smart HIMs" since they can operate in a mixed mode of operations which allows them to perform local routine operations; remote mode for hazardous operations; and mixed mode briefly during transition between the local and remote modes. (LPS Familiarization OV-331-LSC, SPC technical Training, December 12, 1994 p 2-21).

In the current ground system, the patch racks, terminal distributors, and control distributors consist of the same hardware that was used in the Apollo program on the same launch pads and mobile launcher platforms. The Apollo program used a point-to-point architecture that is extremely limited in expandability and is totally based on specifications that are not supported anywhere except at KSC.

What Is INCS?

To best understand INCS a break down of the system will be discussed to gain the following perspectives: Technology, Philosophy, and Benefits.

INCS - Technology

The technical part of INCS is replacing the current system with a new GSE control system for the shuttle program, which can also be used on future programs. It is based on programmable logic controllers and real-time

communications busses. INCS technology is based on industry standards, utilizing industry proven technology, and simplifying the ground control system. This includes changing the total architecture of the KSC ground launch control system enabling the use of COTS parts and intelligent end items, enables safety modifications.

INCS – Technology

There are a lot of inefficiencies in the business process, logistics process, and shuttle processing that can be alleviated with a little change in the thoughts and a change in processes. The changes are organizational and business oriented. USA is attempting to gain efficiencies and cost savings by many different means; one of which is reorganizing the employees based on the High Performance Organization (HPO) format used at other large manufacturing companies. INCS is a GSE system, which means that it must be under one of the two manufacturing centers.

The appropriate personnel will be relocated into the new GSE system and INCS will fulfill its charter and support the overall operations out of both HPOs. This means that INCS will need the authority to design, implement, operate, and maintain the new GSE system.

INCS - Benefits

The one benefit that NASA and USA consider the most important is the cost savings. There are processing benefits and enhancements, safety improvements, and operational enhancements that carry more weight with the operators and maintaining organizations but they are not directly equivalent to

some cost savings. Actual cost savings will be in excess $35 Million over the life of the shuttle program (Bodziak, Brown, Meilbye, & Kimmons (2002)).

There are enhancements that come with the installation of INCS to benefit both safety and processing efficiencies. Processing efficiencies such as in-place calibrations of transducers can be done without all the overhead of LPS and System Engineering (SE) support. The system instrumentation will remain active constantly, which means a user can look at a screen in his office and see the status of his system without having to power it up from the firing room location. The instrumentation will last longer since most electronics fail quicker if they are power cycled often.

A specialized team called the "Red Crew" exists to quickly enter hazardous areas and repair GSE as needed in critical testing and launch countdown. Although INCS will not eliminate the need for red crews, it will reduce the time that is required for the crew to be in a hazardous environment. The red crew is specifically certified to wear Self Contained Apparatus Protective Equipment, (SCAPE) suits. SCAPE operations allow the system to continue working without having to start hazardous operations then stop them, and then restart them.

INCS has the ability to add any system modifications in a very quick mode. This allows the addition of safety systems, which includes modifications to make the systems safer, and the addition of instrumentation to allow the users to see more of the system during hazardous situations.

Currently any addition or change to the system can take years to

implement thus subjecting the users to the hazardous situation until the changes can be implemented. Currently INCS has installed a prototype system at Pad B, called the "Pathfinder" which became operational in the Fall of 2002.

The organizational changes and business changes have been recommended to upper management. INCS is working with NASA and USA executive management to secure funding and begin additional installations in the next couple of years (Bodziak, Brown, Meilbye, and Kimmons 2002).

Failure of Components

Failure modes of current GSE infrastructure including only the HIM and GSE related automated Hardware were diligently documented in the Problem Reporting and Corrective Action (PRACA) paper system. After repair and closure of paper, information was entered into a database that referenced the failed device and a summary of the problem. These problem reports can be accessed by query to the WebPcass / Adam Data Warehouse website for the Pathfinder components. Another secondary database called Maximo will be utilized to capture failures of the existing GSE infrastructure and related HIM equipment components. The two reports from these databases will be pulled and utilized for quantitative data and analysis.

Data Gathering

A data warehouse was created in 1998 called ADAM. This warehouse is an electronic collection of all problem reports that have been documented on the Space Shuttle program. A capability exists to pull data from the ADAM Warehouse through a link called WebPCASS. In the WebPCASS section, a data query is built based on the desired output, by system. When the query for PAD electrical data is built, all problem reports are summarized and additional review will need to be performed to find the relevance to the subject the writer is studying. The relevance of this database with this study is to conglomerate the amount and types of failures associated to GSE.

Another form of documentation associated with GSE failures is the USA trend analysis report for GSE. The trend analysis report is a summary of GSE failures. It provides annual summary tracking of HIM failures. (United Space Alliance Monthly Trend Analysis Report, September, 1997).

There is a Logistics Support Request (LSR) data-gathering tool that will be reviewed and possibly used during this study. The LSR database shows the ground support equipment items that have to be ordered as a replacement for failed GSE. These orders are tracked and may, upon review, show findings relevant to the failures of specific GSE. These findings could present themselves as evidence to support a newer GSE infrastructure due to high failure rate and / or possible obsolescence. The LSR is a summary of logistics request to replace GSE parts. Although the breakdown can be mapped to failures of the old infrastructure units, there is some concern to the writer that there is an element of

missing data since all units are not replaced. Some GSE support units are repaired. These repairs, although linked to a failure, are not charted by logistics as a replacement. Therefore, the validity of the data in the report is compromised since it would lack full disclosure of GSE failures. (United Space Alliance Logistics Support Request database, 2003)

A secondary database called Maximo provides tracking associated with LPS GSE HIM failures. This database is maintained by USA and since it's inception in the late 1990's is one of the best problem report tracking databases for the purpose of gathering the needed data for this analysis. A query of the top 300 GSE component failures was pulled for the months starting April 1, 2003 and ending at April 1, 2004. An eight-page report was produced showing part number and description, failure count, percentage of failure rate and installed base count, (Appendix A1, Maximo Production Database). With the exception of infrequent power outages or maintenance downtime, the run-time of these components support 24-hour non-stop operations. (Rodney C. Prothero, USA Intermediate Lab Maintenance Facility (ILMF) Technician, September 25, 2004)

New Infrastructure component Relevant Literature

Jim Morrison, Component Engineering Department for Rockwell Automation, independently performed a formal study of the new GSE industrial equipment, based on Rockwell Automation architectural components. This report produced a summary of the failures on the identical INCS equipment components. The Allen Bradley (AB) components were used to produce mean time between failures (MTBF) from April 1998 to April 1999. This report included the AB

processor and the PLC installed base in a similar configuration to the Kennedy Space Center new infrastructure upgrade. Although the components are identical, the actual run-time of these components was not physically located at the Kennedy Space Center. The installed base of these components were summarized from various industrial-manufacturing plants in the United States and are governed by various companies. Allen Bradley and Rockwell Automation continue to provide the tracking of failures on their products by monitoring the installed base. The report was analyzed by the writer for statistical data since it contains the best focus of an industrial command / control based equipment similar to the Pad B Pathfinder. However, there were missing pieces in the final report that did not cover the number of components in the installed base.

The databases that currently exist at KSC will be used by the writer in assimilating and organizing data on the both the new infrastructure components and the old HIM components. The Maximo report will be utilized by the writer for the HIM component installed base and failures. The INCS Pad B Hyper Farms Parts List (Appendix A2) will be used for the installed base for the Pathfinder. The Adam Warehouse WebPcass database will be utilized for the Pathfinder failures which holds recent problem report summaries. The writer will estimate a measurable failure rate associated with both sets of equipment that support the Shuttle ground operation's GSE end-items and will try to assess the correctness of the decision to continue with future new installations. Quantitative data will be used to support or not support the recommendation to continue future industrial

equipment component installations based on the inferential statistics.

The Hypotheses

The first hypothesis states that there is a significant difference in the failure rate of the current GSE infrastructure components utilizing the HIM and failure rate of the new Pathfinder infrastructure system utilizing the Rockwell Automation components. Furthermore, Pathfinder infrastructure failure rates will be less than HIM infrastructure failure rates.

The second hypothesis is that the number of support personnel required for the Pathfinder infrastructure will be less than the number of support personnel of the HIM infrastructure.

CHAPTER III

RESEARCH METHODOLOGY

The data for this research project was gathered by utilizing documentation from United Space Alliance, NASA databases, and interviews within the Launch Operation's INCS department engineers and the Launch Processing System technicians.

A Maximo secondary database will be utilized to produce the failure reports on the key GSE components of the LPS HIM components. A Maximo query report of the Top 300 LPS component failures is illustrated in Appendix A1. This report is a snap shot in time spanning from the dates April 1, 2003 to April 1, 2004. After the Maximo report was received, a breakdown of the report had to occur to exclude non-Him related components needed for this analysis. See Table 3.1 for the sample report. It will be used to gather the number of components and the failures associated with those components. The HIM infrastructure supports a 24-hour, 365-day run-time operation. The total run-time for this infrastructure is 24 X 365 equaling 8760 hours per year.

LPS Item Number	ORG	Fail Count	% Fail Rate	Part Number	Description	Installed Count	
1	LPS						
2	LPS						
3	LPS						
4	LPS						
5	LPS						
6	LPS						
7	LPS						
8	LPS						
9	LPS						
10	LPS						
11	LPS						
12	LPS						
13	LPS						
14	LPS						
15	LPS						
16	LPS						
17	LPS						
18	LPS						
19	LPS						
20	LPS						
					Totals	x	

Table 3.1 LPS HIM component Failures.

Appendix A2 contains the Pathfinder parts list and illustrates the numerous Pathfinder components. This data was pulled from a parts list that documented the Pathfinder installed industrial based components at the PAD B location. After the parts list was received, a breakdown of the report had to occur to exclude non-electrical components such as labels, adhesives, cabinets, screws and bolts. What remains on the final report will be the key electrical modules and supporting infrastructure components for the Pathfinder installed base. The sample report is illustrated in Table 3.2. It will be used to gather the number of components in the installed base for comparison to the legacy LPS system. The Pathfinder infrastructure supports a 24-hour, 365-day run-time operation. The total run-time for this infrastructure is 24 X 365 equaling 8760 hours per year.

					PATHFINDER Components and Failure Count							
PART OR STOCK NUMBER	Failure Count	DESCRIPTION	Rack 1 QTY	Rack 2 QTY	Rack 3 QTY	Rack 4 QTY	Rack 5 QTY	Rack 6 QTY	Rack 7- QTY	Rack 8 QTY		EACH TOTALS
INCS Part 1												
INCS Part 2												
INCS Part 3												
INCS Part 4												
INCS Part 5												
INCS Part 6												
INCS Part 7												
INCS Part 8												
INCS Part 9												
INCS Part 10												
INCS Part 11												
INCS Part 12												
INCS Part 13												
INCS Part 14												
INCS Part 15												
INCS Part 16												
INCS Part 17												
INCS Part 18												
INCS Part 19												
INCS Part 20												
Total Failure Count					TOTAL INCS PATHFINDER PARTS							x

Table 3.2 Pathfinder Component Parts and Failures

The Pathfinder equipment at the PAD B location, which has been installed for two years, will be compared to the 10-year installed base for HIM and HIM 2 (HIM II) components. For the purposes of this comparison study, the failures of both systems are gathered for a one year period from April 1, 2003 to March 31, 2004 and will provide a like comparison.

The problem reports for the pathfinder were gathered from the Adam Warehouse WebPcass system as seen in Appendix A3. The total failures will be placed, next to the applicable failed component in the second column of table 3.2 (Failure count).

During a secondary database query utilizing Maximo, where the top 300 LPS components were queried, the report yields the installation units, failures, and run-time for the one-year of period. The report was presented to several experts in the engineering and technical community for a recommendation on correlating the data. Based on their reviews and recommendations, the final queries were pulled for the legacy equipment from the Maximo database. This data is represented in table 3.1.

Engineering recommended the use of the PAD B installation component(s) be compared to the HIM Top 300 failure components since both infrastructures are based on a 24-hour, 365-day run-time operation. This produces quantifiable statistical sample data.

A summary of the component failure data results was gathered from the Table 3.1 and 3.2 data reports and is illustrated below in Table 3.3.

Table 3.3

Data Summary

	Number of Components / Sample Proportion / (Point interval)	Total Failures		
HIM Equipment 1				
Installed Base	x	x		
Estimate of Runtime				
24 Hours X 365 Days	x			
Pathfinder Equipment 2				
Installed Base	x	x		
Estimate of Runtime				
24 Hours X 365 Days	x			

Table 3.3 Data Summary.

The first sub problem was to estimate the failure rate of the old GSE infrastructure components. The 99% confidence interval for proportions will be used to make this estimate.

The second sub problem was to estimate the failure rate of the new industrial based technology components used in the INCS Pathfinder infrastructure upgrades. The 99% confidence interval for proportions will be used to make this estimate. If the two confidence intervals do not overlap and the Pathfinder confidence interval is less than the HIM interval, then there is evidence to support for the first research hypothesis. However, a proportions test will also be used to test the first research hypothesis.

The third sub problem was to compare the failure rate of the old GSE infrastructure components and the failure rate of the Pathfinder components.

The first hypothesis states that the failure rate of the Pathfinder infrastructure will be less than the failure rate of the HIM infrastructure. A test of the difference in proportions will be used to test the null hypothesis. The test will be conducted at the .01 level of significance. The population of failures for Him infrastructure is P_{him}. The population of failures for the Pathfinder infrastructure is P_{path}.

The Null hypothesis states that P_{him} failures are less than or equal to P_{path} failures.

$$H_o : P_{him} <= P_{path}$$

The alternate hypothesis states that P_{him} failures are greater than P_{path} failures.

$$H_a : P_{him} > P_{path}$$

The Summary of Data Table 3.3 is used as inputs to the statistical data analysis. The Triola9E Statdisk software performs the hypothesis testing.

The first hypothesis is supported if the failures of the Pathfinder infrastructure equipment are less than the failures of the HIM infrastructure equipment.
If the failure rate of the HIM infrastructure components exceeds a failure rate of the Pathfinder components, the null hypothesis will be rejected since there will be evidence to support the first research hypothesis. If this happens there will be a finding to support future infrastructure upgrades.

The fourth sub problem was to compare the number of support personnel in the HIM infrastructure with the number of support personnel in the Pathfinder infrastructure. The second research hypothesis is that the number of support personnel required for the Pathfinder infrastructure will be less than the number of support personnel of the HIM infrastructure. The data to test the second research hypothesis will come from USA management in the departments 52740 and 53601. Data will be displayed as illustrated in Table 3.4.

GSE INFRASTRUCTURE SUPPORT PERSONNEL		
Month in 2003/2004	HIM Personnel	Pathfinder Personnel
April		
May		
June		
July		
August		
September		
October		
November		
December		
January		
February		
March		
Totals:		

Table 3.4 GSE Infrastructure Support Personnel

The mean and standard deviation for the sample data will be computed in statdisk for the difference of independent means.

The Null hypothesis states that μ_{him} support personnel are less than or equal to μ_{path} support personnel.

$$H_o : \mu_{him} <= \mu_{path}$$

The alternate hypothesis states that μ_{him} support personnel are greater than μ_{path} support personnel.

$$H_a : \mu_{him} > \mu_{path}$$

The test will be conducted at the .01 level of significance. If the Null is rejected and the $\mu_{path} < \mu_{him}$, then the second research hypothesis will have been supported.

CHAPTER IV

DISCUSSION OF RESULTS

The first sub problem was to estimate the failure rate of the old GSE infrastructure components. The 99% confidence interval for proportions was used to make this estimate.

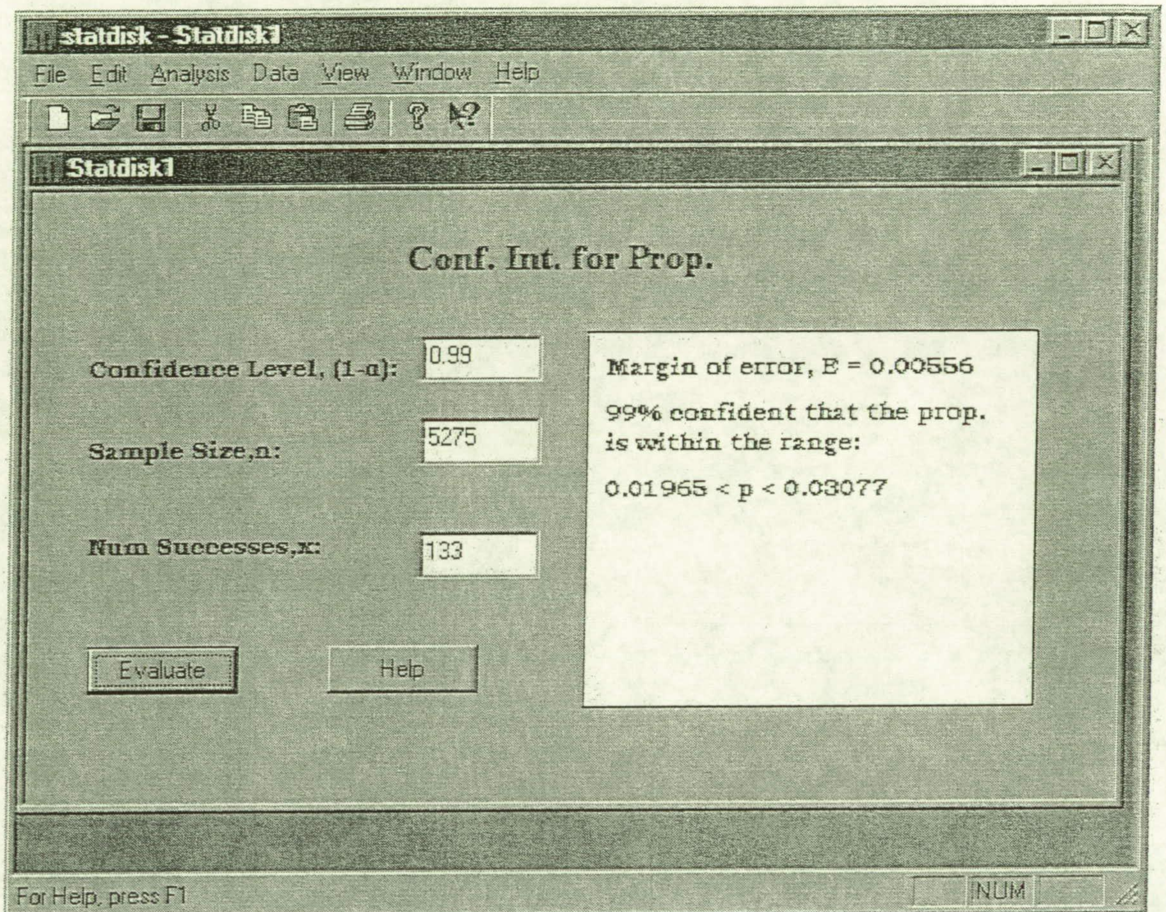
The data for sub problem one is illustrated in table 4.1. The Statdisk calculation for the 99% confidence interval follows the data table.

LPS Item Number	ORG	Fail Count	% Fail Rate	Part Number	Description	Installed Count	
1	LPS	63	33.51	83K01132-510	HIM II HPA	188	
11	LPS	15	1.15	83K01150-701	HIM II 8RCC-A	1303	
20	LPS	10	8.85	83K01180-101	HIM II VME167-STD GICC	113	
39	LPS	6	0.86	83K01154-801	HIM II 8AIC-N	699	
43	LPS	5	9.62	83K01180-102	HIMII-VME167-RUG GICC	52	
56	LPS	4	50	83K01180-104	HIMII-FIT CPU	8	
73	LPS	3	1.73	83K01154-826	HIM II 4AIC-S	173	
74	LPS	3	1.83	83K01136-504	HIM II Front Panel Assy	164	
76	LPS	3	0.98	78k00477-039-D-NS	HIM D CARD	305	
106	LPS	2	1.67	83K01152-707	HIM II 4AOC-H	120	
107	LPS	2	4.26	83K01146-704	HIM II 16DI-2D	47	
108	LPS	2	0.25	83K01146-702	HIM II 16DI-D	813	
109	LPS	2	14.29	83K01133-201	HIM II -Peripheral Chassis Assy	14	
154	LPS	1	0.74	83K08175-711	HIM II BTC	136	
156	LPS	1	1.61	83K01154-819	HIM II 8AIC-U	62	
157	LPS	1	14.29	83K01154-714	HIM II 4AIC-V07	7	
158	LPS	1	2.56	83K01154-702	HIM II 8AIC-N01	39	
159	LPS	1	5.88	83K01152-706	HIM II 4AOC-H03	17	
160	LPS	1	0.63	83K01148-705	HIM II GTC,CCMS 1V IN,15V OUT	158	
161	LPS	1	2	83K01146-707	HIM II GDB ID-DID	50	
184	LPS	1	0.78	78K00477-059-D-NS	HIM D CARD	128	
185	LPS	1	0.25	78K00474-039-A-NS	HIM A CARD	405	
186	LPS	1	11.11	78K00459-269-W-NS	HIM W CARD	9	
187	LPS	1	2.7	78K00459-260-W-NS	HIM W CARD	37	
188	LPS	1	0.87	78K00459-209-N-NS	HIM N CARD	115	
189	LPS	1	0.88	78K00453-029-S	MASTER CONTROL CARD	113	
		133			Totals	5275	

Table 4.1 LPS HIM component Failures.

The 99% confidence interval for proportions for HIM infrastructure failures is shown below.

Sub Problem 1
HIM infrastructure Failures:



There is a small margin of error of 0.55% when calculating the confidence interval for proportions on the failure rate of the HIM infrastructure. The statement can be made with 99% confidence that the failures for the HIM infrastructure are between 1.96% and 3.07% as an annual expected rate of failure.

The second sub problem was to estimate the failure rate of the new industrial based technology components used in the INCS Pathfinder infrastructure upgrades. The data for sub problem two is illustrated in the next two pages in table 4.2.

The 99% confidence interval for proportions was used. The Statdisk representation was not used for the calculation due to the input requirement in Statdisk of having a number of successes greater than or equal to five. The Pathfinder had only one system failure to enter so the Statdisk software would not perform the calculations correctly. Instead, the TI-83 statistical calculator was used.

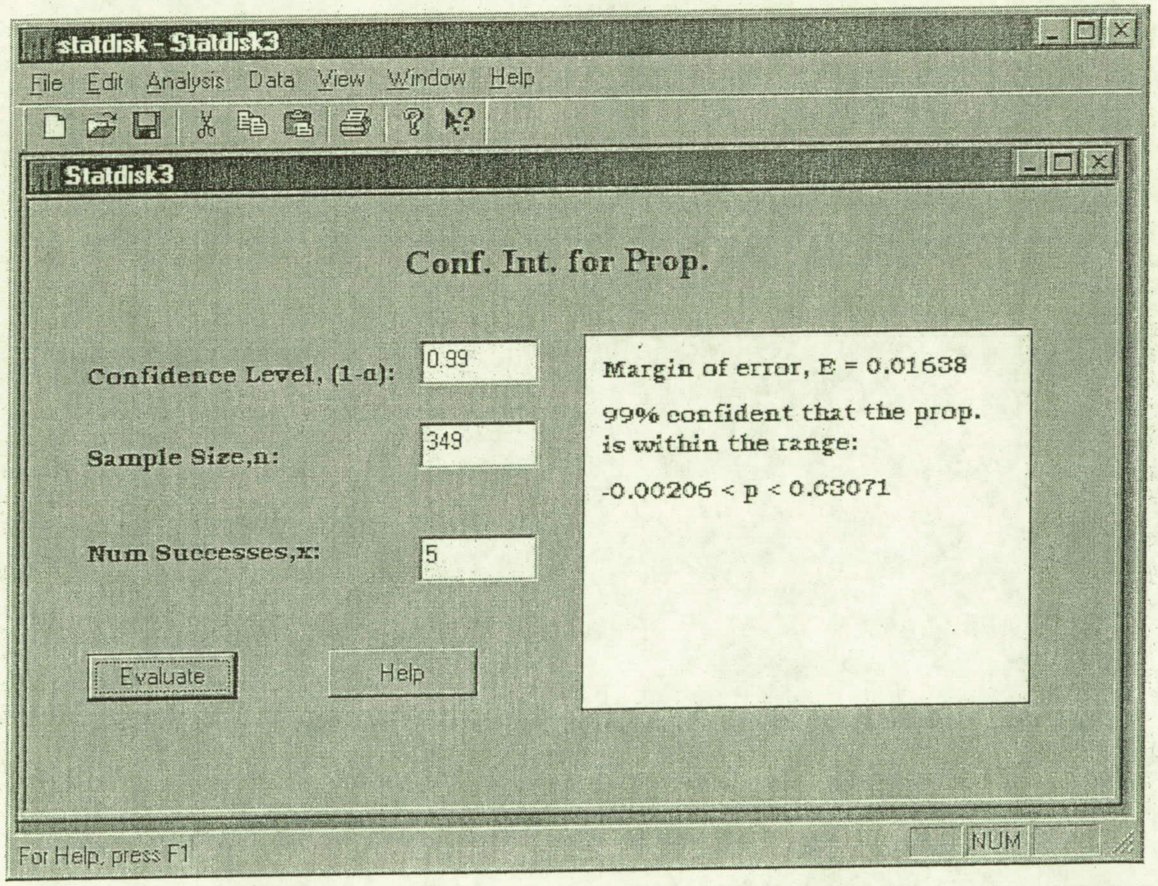
PATHFINDER Components												
PART OR STOCK NUMBER	Failure Count	DESCRIPTION	65002 90K10200- 1 QTY	65301 90K10201- 1 QTY	65302 90K10202- 1 QTY	65401 90K10203- 1 QTY	65402 90K10204- 1 QTY	7867A1 90K10205- 1 QTY	7857A1 90K10206- 1 QTY	7864A1 90K10207- 1 QTY	7874A1 90K10208- 1 QTY	EACH TOTALS
113432		VALVE, SOLENOID 24 VDC								2	2	4
??		DIODE	2									2
1492-CB1G-050		CIRCUIT BREAKER	1	4		1				1	1	8
1492-CB1G-150		CIRCUIT BREAKER		1		1						2
1492-CB1H-100		CIRCUIT BREAKER, SLOW TRIP	3	7	1	4	1	1	1			18
1492-CB1H-500		CIRCUIT BREAKER, SLOW TRIP	2	1		2		1	1			7
1492-CB3G-500		CIRCUIT BREAKER								3	3	6
1497-NP2		TRANSFORMER								1	1	2
1734-ACNR15		CNET ADAPTER, POINT I/O		1		1		1	1	1	1	6
1734-BNCP		CONNECTOR BNC				4						4
1734-FPD		FIELD PWR DISTR MODULE				1		1	1	1	1	5
1734-IB4		DIGITAL DC INPUT MODULE						1	1	1	1	4
1734-IE2V		ANALOG I/O MODULE				3		1	1	1	1	7
1734-OB2EP		I/O PROTECTED OUTPUT MODULE						2	2	2	2	8
1734-OW2		DIGITAL CONTACT OUTPUT MODULE				1						1
1734-OX2		DIGITAL CONTACT OUTPUT MODULE		1		1		1	1	1	1	6
1734-TBS		TERMINAL BASE				7		5	5			17
1756-1F6I		ANALOG I/O MODULE			4		4					8
1756-A10		CHASSIS, 10 SLOT		1								1
1756-A17		CHASSIS, 17 SLOT			1	1	1					3
1756-A7		CHASSIS, 7 SLOT	3					1	1			5
1756-BNCP		CONNECTOR BNC	4									4
1756-CNBR		COMM MODULE CONTROLNET	5	2	1	3	1	5	5			22
1756-DNB		COMM MODULE DEVICENET		1		1						2
1756-ENET		COMM MODULE ETHERNET	1	1		1						3
1756-IB16		DIGITAL DC INPUT MODULE	1	1	2	3	2	1	1			11
1756-IF16		ANALOG I/O MODULE		1	2	5	2	1	1			12
1756-IR6I		ANOLOG I/O MODULE - RTD			1		1					2
1756-L55M12		CONTROLLOGIX PROCESSOR	2	1	1	1	1					6
1756-OB16		DIGITAL DC OUTPUT MODULE	1			6						7

1756-OB8EI		DIGITAL DC OUTPUT MODULE		1	5		5	1	1			13
1756-OF8		ANALOG I/O MODULE	1		1		1					3
1756-PB72	1	POWER SUPPLY						1	1			2
1756-PB75		POWER SUPPLY	3	1	1	1	1					7
1757-SRM		SRM MODULE	2									2
1786-BNCP		CONNECTOR, BNC								2	2	4
1786-TBYR		TAP, CONTROLNET	2					1	1			4
1786-TPRS		TAP, CONTROLNET				4						4
1786-TPS		TAP, CONTROLNET	8									8
1786-TPYR		TAP, CONTROLNET		10	2		2					14
1786-XT		TERMIINATOR, CONTROLNET	6	10	2	4	2	1	1	4	4	34
1794-AENT		CNET ADAPTER, FLEX I/O	1	1		1						3
1794-IE4XOE2		DIGITAL DC I/O COMB MODULE	1	1		1						3
1794-OW8		DIGITAL DC RELAY MODULE	1	1		1						3
1794-TB3		TERMINAL BASE	2	2		2						6
20AD027A3AYNACNN		POWERFLEX 70								1	1	2
79K03438A4C11		TRANSDUCER, PRESS 0-75 PSIA								1	1	2
79K03438U5C05		TRANSDUCER, PRESS 0-5 PSID								1	1	2
913B-30-B		SENSOR, CURRENT DC		4		4						8
AS-100F-24/DRL		POWER SUPPLY								1	1	2
M700-HN125		RELAY	5	5		5						15
MS24140-02		RELAY										0
MS3106R-14S-6S		CONNECTOR, TRANSDUCER CABLE								2	2	4
OCM-CTN-13-P-D-ST-24V-MM		FIBER MODULE, MULTIMODE		3		3						6
OCM-CTN-85-P-D-ST-ACV-MM		FIBER MODULE, MULTIMODE		1		1						2
S-320-27		DC POWER SUPPLY	1	1		1						3
		TOTAL INCS PATHFINDER PARTS										349

Table 4.2 PATHFINDER Components

The 99% confidence interval for proportions for the Pathfinder infrastructure failures is shown below, however, using 5 successes rather than the actual 1, does not give a true picture. Using a TI-83 statistical calculator the 99% Confidence interval was calculated with a sample having only 1 success in 349 trials. The CI is -.0045, .01024 .

Sub problem 2
Pathfinder Infrastructure Failures



Note: There was only one failure in the sample data for Pathfinder. Since the Statdisk software would not support the number of successes at a rate of less than 5, the calculations were performed on a TI-83 statistical calculator.

There is a very small margin of error in calculating the confidence interval of proportions for the Pathfinder failures at 0.287%. The statement can be made with 99% confidence that the failures for the Pathfinder infrastructure are between -.45% and 1.024% as an annual expected rate of failure. Since having a negative number of failures is not feasible, the practical values of the interval are 0% and 1.024%. It was stated in Chapter 3's methodology that if the two confidence intervals do not overlap and the Pathfinder confidence interval is less than the HIM interval, then there is support for the first research hypothesis. The proportion intervals are as follows:

HIM infrastructure	between 1.96% and 3.07%
Pathfinder infrastructure	between 0.0% and 1.024%.

The proportions do not overlap and furthermore, the Pathfinder interval is significantly less than the interval for HIM. This data provides needed evidence that supports research hypothesis one.

In addition to the confidence interval for proportions, a proportions test was used to test the first research hypothesis. The data for the proportions test input is illustrated in table 4.3.

	Number of Components	Total Failures		
	Sample Proportion			
	(Point interval)			
HIM Equipment 1				
Installed Base	5275	133		
Estimate of Runtime				
24 Hours X 365 Days	8760			
Pathfinder Equipment 2				
Installed Base	349	1		
Estimate of Runtime				
24 Hours X 365 Days	8760			

Table 4.3 Summary of Failures in both HIM and Pathfinder infrastructures

The Statdisk software could not be used for the test because the software required a minimum of 5 successes in the sample and there was only 1 success sample in Pathfinder. Consequently, this test was performed using the TI-83 Statistical calculator. The null hypotheses stated that the two proportions were equal. The alternative was that the proportion of failures for HIM was larger than that for Pathfinder. The p-value for the test was .004 which is less than the .01 that was chosen as the significance level. Consequently the null is rejected and the test furnishes additional evidence to support the research hypothesis.

A statement can be made that I am 99% confident that the proportion of the HIM failures is greater than the proportion of the Pathfinder failures. The p-value is the probability of obtaining the difference between the sample proportions if there is really no difference in the target populations. The p-value for the proportions test was 0.004 which means there is less than 4 chances in 1000 that one could obtain the observed difference in the samples with the population proportions being the same. Consequently, the conclusion is that the failure rate for the Pathfinder system is really less than that of the HIM system.

The fourth sub problem was to compare the number of support personnel in the HIM infrastructure with the number of support personnel in the Pathfinder infrastructure. The data to test the second research hypothesis came from USA management in the departments 52740 and 53601. The data is illustrated in Tables 4.3.A for the HIM infrastructure support personnel and 4.3.B.for the Pathfinder infrastructure support personnel.

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GSE INFRASTRUCTURE SUPPORT PERSONNEL (Manager, Engineer, Test, Maintenance, Repair, Documentation, other)

	Total Support Personnel	Manager	Engineer	Test	Maintenance	Repair	Documentation	Other (SE)		
01-Apr-03	14	2	2		7	3				
01-May-03	14	2	2		7	3				
01-Jun-03	14	2	2		7	3				
01-Jul-03	14	2	2		7	3				
01-Aug-03	14	2	2		7	3				
01-Sep-03	14	2	2		7	3				
01-Oct-03	14	2	2		7	3				
01-Nov-03	14	2	2		7	3				
01-Dec-03	14	2	2		7	3				
01-Jan-04	14	2	2		7	3				
01-Feb-04	14	2	2		7	3				
01-Mar-04	14	2	2		7	3				
01-Apr-04	14	2	2		7	3				

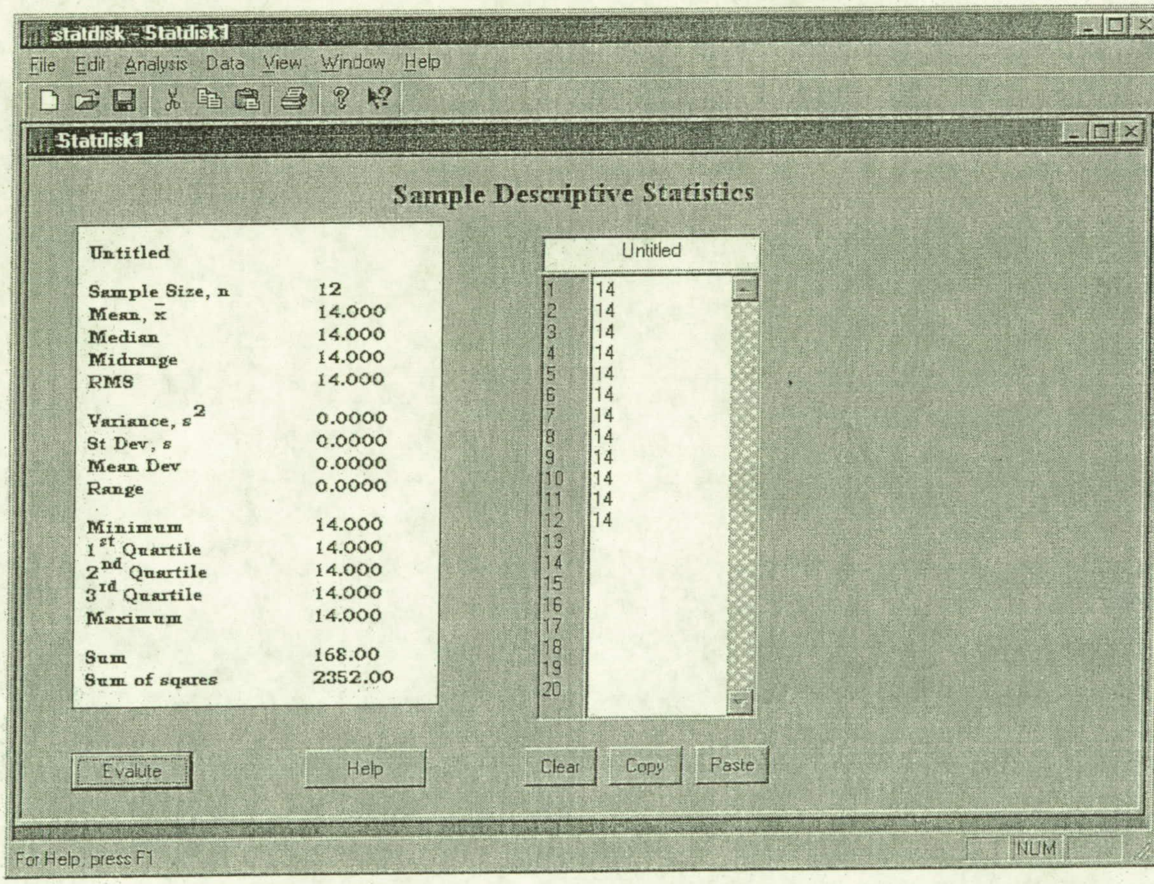
Table 4.3.A HIM Infrastructure Support Personnel from 4-01-2003 to 3-31-2004

GSE INFRASTRUCTURE SUPPORT PERSONNEL (Manager, Engineer, Test, Maintenance, Repair, Documentation, other)

	Total Support Personnel	Manager	Engineer	Test	Maintenance	Repair	Documentation	Other (specify)
01-Apr-03	6	1	2	0	2	0	1	
01-May-03	6	1	2	0	2	0	1	
01-Jun-03	5	1	2	0	2	0	0	
01-Jul-03	5	1	2	0	2	0	0	
01-Aug-03	5	1	2	0	2	0	0	
01-Sep-03	6	1	3	0	2	0	0	
01-Oct-03	6	1	3	0	2	0	0	
01-Nov-03	7	1	3	1	2	0	0	
01-Dec-03	7	1	3	1	2	0	0	
01-Jan-04	8	2	3	1	2	0	0	
01-Feb-04	8	2	3	1	2	0	0	
01-Mar-04	10	2	3	1	2	0	2	
01-Apr-04	10	2	3	1	2	0	2	

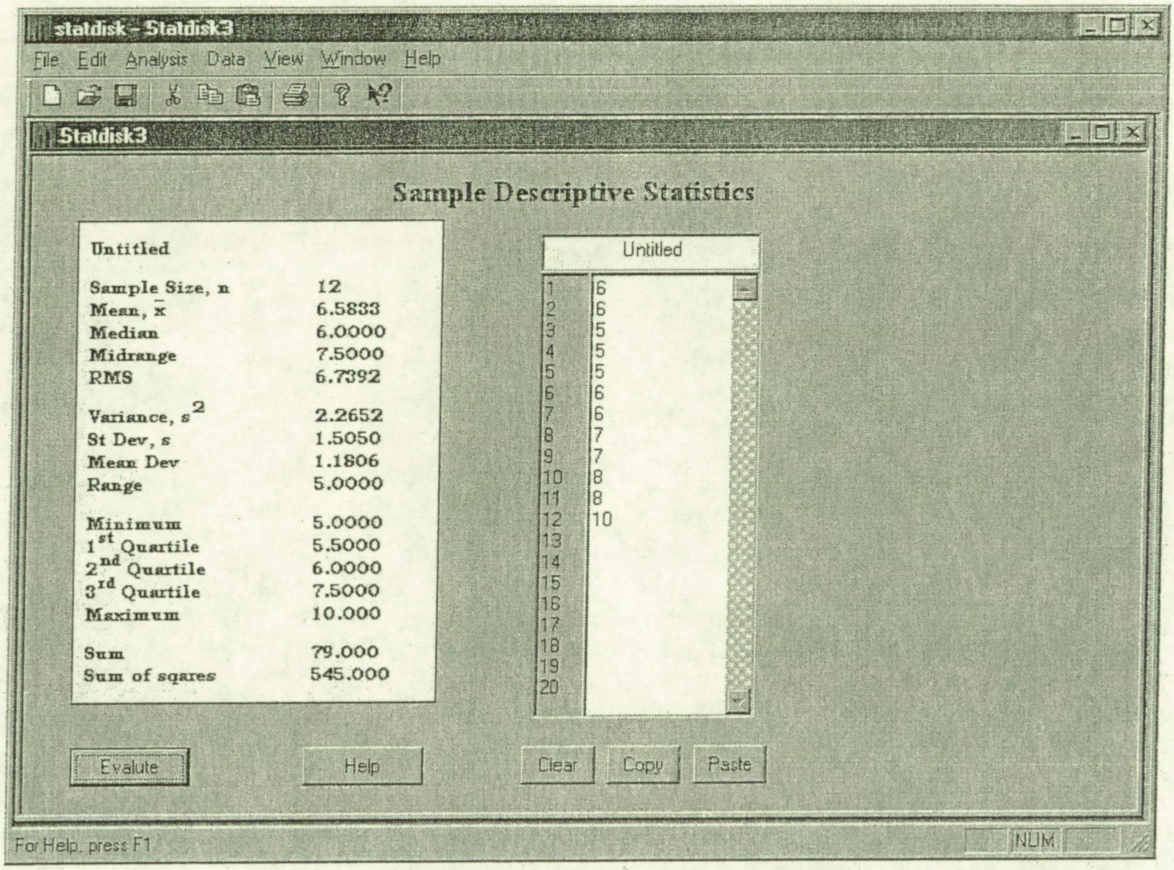
Table 4.3.B Pathfinder Infrastructure Support Personnel from 4-01-2003 to 3-31-2004

The second research hypothesis states that the number of support personnel required for the Pathfinder infrastructure will be less than the number of support personnel of the HIM infrastructure. The following Statdisk output illustrates the calculation of the mean and the standard deviation for the HIM support personnel using the data from 4.3.A as input.



The descriptive statistics for the HIM infrastructure Support Personnel yields the mean of 14.0 and standard deviation of .0.00. The HIM infrastructure was continually staffed with no deviation in personnel for the dates specified.

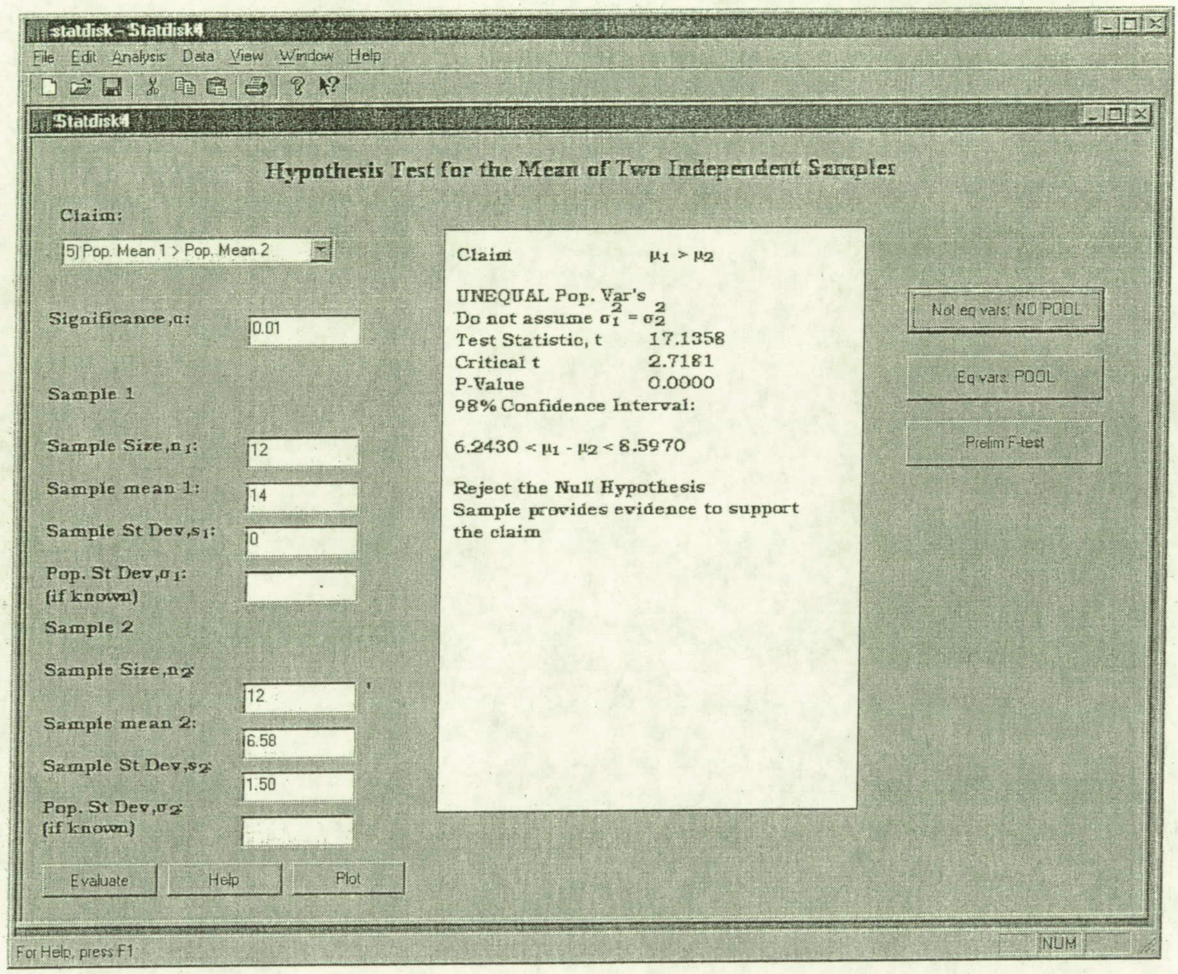
The following Statdisk output illustrates the calculation of the mean and the standard deviation for the Pathfinder support personnel using the data from 4.3.B as input.



The descriptive statistics for the Pathfinder infrastructure support personnel yields the mean of 6.58 and standard deviation of 1.50.

For the second hypothesis, the mean and the standard deviation was found for both the HIM and the Pathfinder infrastructure support personnel. Then

the test for the mean of two independent samples was used to test the hypothesis. The following Statdisk illustration shows the results.



For research hypothesis two, the null hypothesis states that the $\mu_{him} <= \mu_{path}$. The hypothesis test of the two samples was conducted. The Null is rejected. The statement can be made with 99% confidence that a difference does exist between the average number of support personnel for the HIM system and the average number for the Pathfinder system. Furthermore, a statement can be made that the average number of Pathfinder support personnel is

significantly less than the number required for the HIM infrastructure. The p-value is the probability that an observed difference between the samples could exist and the mean number of support personnel in the HIM system can be equal to or greater than that of the pathfinder system. Since the p-value was less than .0001, the statement can be made that there is less than 1 chance in 10,000 that the mean number of support personnel for the two systems is the same. Consequently, the conclusion is that the support personnel for the Pathfinder system is really less than that of the HIM system.

CHAPTER V

CONCLUSIONS AND RECOMMMENDATIONS

This study compared the failure rates of the equipment in both the HIM infrastructure and the Pathfinder infrastructure. In conclusion, it would appear that very different failure rates occur in the Pathfinder infrastructure than in the HIM infrastructure. With additional study, this might lead to the conclusion that the same results could be found when comparing a custom network and information technology architecture to any COTS based architecture.

As technology in the industrial controls area develops, it appears that there is an expectation for more reliable components and less emphasis on repair based on the COTS components being "throw away" items.

This study also compared the support personnel of the applicable equipment in both the HIM infrastructure and the Pathfinder infrastructure. Personnel staffing is structured according to the relative magnitude of the infrastructure but only to the extent where human intervention is necessary and the importance of maintaining acceptable levels of safety are concerned. As industrial controls equipment is installed, a reduction in the personnel staffing is paramount since the reliability of the COTS products lends itself to a lean support staff.

There is a strong need for further research aimed at understanding the possible trend in reduction of workforce after the COTS based infrastructure is

further installed at KSC; and the underlying control of high performance, or lack of failures of the equipment can be continually established.

The current results of this study suggest, at least where safety is paramount, that it is desirable to pursue further infrastructure upgrades. The paradigm shift in equipment and in support personnel will take into consideration, not only a reduced failure rate on equipment, but also a reduction on the staffing personnel needed to support the non-stop information processing demands placed on the Space Shuttle project.

Clearly it would be a mistake to ignore the weight of the results from this study, as they do draw attention to a potential argument to support further GSE infrastructure upgrades in as many of the GSE facilities as possible before the retirement of the Space Shuttle fleet. This upgrade not only increases near term processing efficiencies, leans the support staff, but most of all, lends itself to future "state of the art" GSE infrastructure that will be in place for the next designated space vehicle at the Kennedy Space Center.

This study demands further, more detailed research after additional upgrade installations at the VAB and PAD A sites are completed and 2 or 3 years of runtime have occurred.

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Interviews

Harvey Neil Mizell, Manager, Launch Pad Electrical Systems, September 1, 2004 on the subject of quantitative data gathering for INCS system equipment and component failures.

Rodney C. Prothero, USA Intermediate Lab Maintenance Facility (ILMF) Technician, September 25, 2004 on the subject of quantitative data gathering for legacy equipment failures, specifically related to Ground Support Equipment involving a Hardware Interface Module (HIM).

APPENDIX A1

MAXIMO Database Report

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#1	LPS	63	33.51	83K01132-510	HIM II HPA	197	9	188	63	352.6	5.6
#2	LPS	39	7.66	78K01345-009	Memory Card (4k)	570	61	509	39	65.5	1.7
#3	LPS	38	32.20	78K00021-029	PCM Bit Sync (Model 335)	150	32	118	34	404.9	10.7
#4	LPS	25	3.37	78K00336-030	BAC Card	769	28	741	24	73.5	2.9
#5	LPS	24	9.34	8829	Aydin Monitor	286	29	257	23	66.7	2.8
#6	LPS	23	3.97	551-100515-001A	Logic Power Supply	855	275	580	23	21.4	0.9
#7	LPS	18	10.65	551-1338-01-005	Non-RAM Option Plane	241	72	169	12	29.0	1.6
#8	LPS	18	7.79	78K00140-040	PFP	272	41	231	17	85.0	4.7
#9	LPS	17	25.76	550-2011	RAIT Tape Unit	74	8	66	16	26.0	1.5
#10	LPS	17		566-200028-001	M4 Tape Drive	28	28	0	17	10.0	0.6
#11	LPS	15	1.15	83K01150-701	HIM II 8RCC-A	1542	239	1303	14	49.3	3.3
#12	LPS	13	3.32	516-200145-001	Rectifier Filter	566	175	391	13	9.8	0.8
#13	LPS	13	17.57	C1003G	HP Terminal	100	26	74	10	22.4	1.7
#14	LPS	13	8.23	78K00210-050	Processor Data Monitor	168	10	158	13	16.5	1.3
#15	LPS	12	24.49	78K00316-030	CDBFR Front Panel	60	11	49	12	64.5	5.4
#16	LPS	12	15.19	C2001A	Printer, Laser	97	18	79	12	55.5	4.6
#17	LPS	12	4.90	LXS-EE-5-OVR	Lambda Power Supply	282	37	245	12	29.3	2.4
#18	LPS	11	6.55	551-1295-01-010	CPU Plane II	213	45	168	9	35.0	3.2
#19	LPS	10	3.66	551-1304-01-001	CPU Control Panel	298	25	273	10	11.5	1.2
#20	LPS	10	8.85	83K01180-101	HIM II VME167-Std GICC	175	62	113	6	6.5	0.7
#21	LPS	10	5.35	78K00156-020	Power Distribution Panel	206	19	187	10	25.5	2.6
#22	LPS	10	2.16	80K54837-6	AC/DC Power Supply	644	180	464	10	20.0	2.0
#23	LPS	9	36.00	280016-1	5V 150A Power Supply Assembly	33	8	25	8	35.4	3.9
#24	LPS	9	6.21	551-1299-01-004	XDMP Plane	185	40	145	8	19.5	2.2
#25	LPS	9	100.00	80K58972-2	Carrier With Drive Assembly	57	48	9	9	1.5	0.2
#26	LPS	9	14.06	80K55552-1	Laser Printer Interface Board	75	11	64	8	7.0	0.8
#27	LPS	8	16.33	78K01364-069	Bus Monitor Card	54	5	49	6	27.0	3.4
#28	LPS	8	25.81	80K56861-1	MT-691 Line Printer	35	4	31	6	32.0	4.0
#29	LPS	7	12.50	78K00383-020	MUX B Card	77	21	56	7	20.8	3.0
#30	LPS	7	41.18	78K01367-070	Master Scanner	25	8	17	1	3.5	0.5
#31	LPS	7	8.97	C1401A	HP Keyboard	104	26	78	7	0.0	0.0
#32	LPS	6	3.51	551-1294-01-011	CPU Plane I	212	41	171	5	17.0	2.8

Installed BASE

mtbf = 10,000 / 4160 failures 50% or more

10000 - 4160 ≈ 1 year AVG

Average time 133

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#33	LPS	6	0.55	76-28041-003K	10 X 2 Switch Card	1144	44	1100	5	2.0	0.3
#34	LPS	6	17.65	78K00636-010	FIFO Card 2	43	9	34	6	39.0	6.5
#35	LPS	6	17.65	78K00617-079	FIFO Card 1	43	9	34	6	37.2	6.2
#36	LPS	6	10.71	78K00361-029	MUX A Card	74	18	56	6	13.8	2.3
#37	LPS	6	2.38	78K00195-050	Channel Board	322	70	252	5	4.0	0.7
#38	LPS	6	3.87	LXS-B-5-OV-R	Lambda Power Supply	171	16	155	6	8.8	1.5
#39	LPS	6	0.86	83K01154-801	HIM II 8AIC-N	886	187	699	6	22.0	3.7
#40	LPS	5	2.94	551-1297-01-007	4 Port Controller	213	43	170	3	12.0	2.4
#41	LPS	5	4.17	551-1338-01-005I	Non-RAM Option Plane, Flying	132	12	120	5	22.0	4.4
#42	LPS	5	4.63	78K00358-029	Stack Interrupt	118	10	108	5	13.8	2.8
#43	LPS	5	9.62	83K01180-102	HIM II-VME167-RUG GICC	73	21	52	1	2.0	0.4
#44	LPS	5	8.93	OEM5N5.7-1	5V Power Supply	88	32	56	5	5.4	1.1
#45	LPS	5	2.12	LXS-4-12-R-6411	Lambda Power Supply	274	38	236	4	5.3	1.1
#46	LPS	5	8.06	C2009A	HP Printer Laser Jet IVSI	73	11	62	5	35.0	7.0
#47	LPS	5	5.43	78K00169-030	Power Distribution Panel	101	9	92	5	9.0	1.8
#48	LPS	5	31.25	720494	Dual Digital Demodulator	21	5	16	5	5.0	1.0
#49	LPS	4	11.76	3170-165B	Time Code Generator	52	18	34	3	58.1	14.5
#50	LPS	4	12.12	550-2010	Tape Unit	51	18	33	4	7.5	1.9
#51	LPS	4	66.67	516-200157-001	Line Printer Controller	11	5	6	4	14.5	3.6
#52	LPS	4	4.55	JF751B-2000-0000	Buffer AC/DC Power Supply	102	14	88	3	9.0	2.3
#53	LPS	4	11.76	BC635VME	Time Code Processor Board	40	6	34	4	5.0	1.3
#54	LPS	4	30.77	AT-MC15-10	MC15 Ethernet Media Converter	16	3	13	4	0.0	0.0
#55	LPS	4		9914-801-12-M	M4 Tape Drive	13	13	0	4	2.0	0.5
#56	LPS	4	50.00	83K01180-104	HIM II-FIT Central Processing Un	14	6	8	3	11.5	2.9
#57	LPS	4	1.41	80K54843-1	WDM Digital Transmitter	366	82	284	0	0.0	0.0
#58	LPS	4	25.00	78K00348-040	AVL Card	19	3	16	3	7.5	1.9
#59	LPS	4	7.14	78K00342-049	Slave Scanner	64	8	56	2	5.0	1.3
#60	LPS	4	10.00	78K00339-030	GPBIM Card	50	10	40	4	25.8	6.4
#61	LPS	4	6.35	78K00028-009	Keyboard	74	11	63	4	4.0	1.0
#62	LPS	4	10.00	76-28041-002F	10 X 2 Switch Card	45	5	40	3	1.5	0.4
#63	LPS	4	18.18	551-1421-01-003	I/F Controller, ACI modified 50K	23	1	22	4	50.8	12.7
#64	LPS	4	2.92	516-1317-01-000	PIT	313	176	137	4	8.0	2.0

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#65	LPS	3	0.96	2000FP	Monitor	327	13	314	3	0.5	0.2
#66	LPS	3	42.86	4416V	PCM Simulator Card	15	8	7	1	0.0	0.0
#67	LPS	3	1.19	460-5610-501Z	DFL006 Board	287	35	252	3	1.5	0.5
#68	LPS	3	1.63	78K00190-069	Data Edit Keyboard	203	19	184	3	2.3	0.8
#69	LPS	3	8.82	SP3-1601	VSI Power Supply	39	5	34	3	4.0	1.3
#70	LPS	3	11.11	SI-80-013	Frequency Synthesizer	37	10	27	2	12.3	4.1
#71	LPS	3	75.00	FPA570-VT-011	Terminal Subsystem	7	3	4	1	5.5	1.8
#72	LPS	3	50.00	83K02182-102	FIT Tool Assembly (Test Equipmen	8	2	6	2	11.5	3.8
#73	LPS	3	1.73	83K01154-826	HIM II 4AIC-S	207	34	173	3	13.0	4.3
#74	LPS	3	1.83	83K01136-504	HIM II Front Panel Assembly	239	75	164	3	20.6	6.9
#75	LPS	3	42.86	80K58463-4	Sun Ultra 5 CPU	11	4	7	3	0.0	0.0
#76	LPS	3	0.98	78K00477-039-D-NS	HIM D Card	384	79	305	3	7.0	2.3
#77	LPS	3	9.68	78K00339-039	GPBIM Card	41	10	31	2	1.5	0.5
#78	LPS	3	2.75	78K00260-030	Extended Memory Plane	127	18	109	3	43.0	14.3
#79	LPS	3	3.49	78K00194-069	Common Board	114	28	86	2	3.0	1.0
#80	LPS	3	6.52	78K00112-009	TTY Controller	49	3	46	3	12.0	4.0
#81	LPS	3	1.61	76-28041-002C	10 X 2 Switch Card	196	10	186	3	0.0	0.0
#82	LPS	3	300.00	637-100093-001	Raid Controller	17	16	1	3	2.0	0.7
#83	LPS	3	3.66	551-1309-01-005	TTY Controller	88	6	82	3	5.0	1.7
#84	LPS	3	7.89	4400-VX	PCM Bit Sync Card	46	8	38	0	0.0	0.0
#85	LPS	2	1.20	1U10980G01	SB11B-PMC	196	29	167	2	0.0	0.0
#86	LPS	2		460-1096A	PSR021 Card	2	2	0	1	5.4	2.7
#87	LPS	2	2.70	460-2141-501C	VAF055-1 Board	106	32	74	1	1.9	0.9
#88	LPS	2	3.57	78K01310-020	Data Routing Card	61	5	56	2	7.5	3.8
#89	LPS	2	2.63	78K01190-070	Display Processor	91	15	76	2	2.8	1.4
#90	LPS	2	10.53	78K00386-009	Blower Assembly	22	3	19	2	2.6	1.3
#91	LPS	2	3.39	78K00352-039	Bus Terminator Card	65	6	59	2	5.5	2.8
#92	LPS	2	4.76	78K00348-039	AVL Card	45	3	42	2	7.6	3.8
#93	LPS	2	6.45	78K00329-020	Power Distribution Panel	33	2	31	2	2.5	1.3
#94	LPS	2	12.50	78K00306-020	Control Monitor Panel Assembly	20	4	16	1	2.5	1.3
#95	LPS	2	33.33	78K00200-209	XFMR Panel Assembly	9	3	6	2	11.6	5.8
#96	LPS	2	5.88	78K00169-019	Power Distribution Panel	47	13	34	2	6.5	3.3

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#97	LPS	2	5.88	78K00016-129	Status Controller	42	8	34	1	1.0	0.5
#98	LPS	2	1.20	551-1005	Quantum Drive (DLT 4000)	199	33	166	1	0.2	0.1
#99	LPS	2	0.97	551-100314-001	Memory Power Supply	290	83	207	2	4.0	2.0
#100	LPS	2	0.87	516-200161-001	12V Regulator	327	98	229	2	0.0	0.0
#101	LPS	2	1.23	SMM165LOSOP	SPU CPU Board	190	27	163	2	0.0	0.0
#102	LPS	2	2.38	RT151-1	AC/DC Power Supply	113	29	84	2	3.5	1.8
#103	LPS	2	2.60	LXS-CC-20R	POWER SUPPLY	103	26	77	1	2.0	1.0
#104	LPS	2		LBS-62-ST-ST-MDIN-SY	Dual Bypass Switch	2	2	0	0	0.0	0.0
#105	LPS	2	6.25	JF151G-2000-0000	Buffer 300 Amplifier Power Suppl	45	13	32	2	7.0	3.5
#106	LPS	2	1.67	83K01152-707	HIM II 4AOC-H	149	29	120	2	15.0	7.5
#107	LPS	2	4.26	83K01146-704	HIM II 16DI-2D	76	29	47	2	10.0	5.0
#108	LPS	2	0.25	83K01146-702	HIM II 16DI-D	943	130	813	2	9.0	4.5
#109	LPS	2	14.29	83K01133-201	HIM II-Peripheral Chassis Assy	21	7	14	2	2.5	1.3
#110	LPS	2	3.23	80K54846-9	WDM Digital Receiver	75	13	62	0	0.0	0.0
#111	LPS	2	0.90	80K54846-1	WDM Digital Receiver	261	39	222	0	0.0	0.0
#112	LPS	2	0.81	80K52677-2	64K Memory Plane	325	77	248	0	0.0	0.0
#113	LPS	2	40.00	78K02380-029	Front Panel Card	9	4	5	2	3.0	1.5
#114	LPS	2	15.38	460-2142-501B	LLF-001 Card	26	13	13	1	6.6	3.3
#115	LPS	2	40.00	460-1823-501F	ACL009-1 Card	8	3	5	0	0.0	0.0
#116	LPS	2	40.00	460-1058-J	PDT020 Card	11	6	5	2	3.8	1.9
#117	LPS	2	4.44	351-0126-504	Aydin 15V Power Supply	63	18	45	2	0.0	0.0
#118	LPS	2	22.22	460-0921-501X	SLC029-1 Signal Level	13	4	9	0	0.0	0.0
#119	LPS	1	50.00	080136	Power Supply	3	1	2	1	1.5	1.5
#120	LPS	1	5.26	21A074B1-1-21-01	Modem	27	8	19	0	0.0	0.0
#121	LPS	1		22306-003B	Model 2150S Tape Drive	1	1	0	1	0.0	0.0
#122	LPS	1	5.88	460-1095-501K	CSD002 Card	24	7	17	0	0.0	0.0
#123	LPS	1	100.00	460-1095-501J	CSD002 Card	3	2	1	0	0.0	0.0
#124	LPS	1	100.00	460-1095-501	CSD002 Card	3	2	1	0	0.0	0.0
#125	LPS	1	12.50	460-1058-501M	PDT020 Card	13	5	8	0	0.0	0.0
#126	LPS	1	7.69	460-0949-D	LDR023 Card	17	4	13	0	0.0	0.0
#127	LPS	1	20.00	460-0927-H	SLC030 Signal Level	8	3	5	0	0.0	0.0
#128	LPS	1		460-0921-501M	SLC029-1 Signal Level	1	1	0	0	0.0	0.0

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#129	LPS	1	1.64	460-0906-501N	THD001 Card	80	19	61	1	1.6	1.6
#130	LPS	1	2.44	4411-VS	PCM Decommutator	45	4	41	1	0.0	0.0
#131	LPS	1	0.66	USA02P	Power Supply, SCE	177	26	151	1	1.5	1.5
#132	LPS	1	2.78	TDS420A	OSCILLOSCOPE, DIGITAL, STORAGE	36	0	36	1	1.5	1.5
#133	LPS	1	7.69	TDS3032	OSCILLOSCOPE, DIGITAL, STORAGE	13	0	13	1	5.8	5.8
#134	LPS	1		PFC0500-4EH-N	Power Supply	1	1	0	1	9.5	9.5
#135	LPS	1	2.70	PCM-704M	PCM Mux Card	44	7	37	0	0.0	0.0
#136	LPS	1	7.69	MP6-96529	LabArmor Power Supply	15	2	13	0	0.0	0.0
#137	LPS	1	2.44	MODEL 110	Video Amplifier	68	27	41	1	2.2	2.2
#138	LPS	1	8.33	MDX-700L	Mux/Demux Card	15	3	12	0	0.0	0.0
#139	LPS	1	3.85	M800-10P-1AB-5F-110	FDDI Concentrator	30	4	26	1	3.3	3.3
#140	LPS	1	1.39	LNS-Z-5-OV-9679	Lambda Power Supply	86	14	72	1	1.5	1.5
#141	LPS	1	100.00	EBV16-RA	Alpha VME 5/352 (CPU)	3	2	1	1	0.0	0.0
#142	LPS	1	25.00	DVME-622	16 Channel Digital Analog Card	6	2	4	0	0.0	0.0
#143	LPS	1	25.00	D1028L	Display Unit, ADP	5	1	4	1	2.0	2.0
#144	LPS	1		CL812811	Power Supply Board	1	1	0	0	0.0	0.0
#145	LPS	1	25.00	C3167A	Printer, Laserjet	4	0	4	1	6.0	6.0
#146	LPS	1	5.00	AS90	NEC ACCUSYNC 90 Monitor	40	20	20	1	9.0	9.0
#147	LPS	1	2.63	ACC-714M	Analog Mux Card	39	1	38	0	0.0	0.0
#148	LPS	1	11.11	A21UJC1Z9P-C128CY	Sun Ultra 5 CPU	32	23	9	1	9.0	9.0
#149	LPS	1	100.00	9310-7057	Time Code Generator/Translator	1	0	1	1	21.9	21.9
#150	LPS	1	3.45	897406-1	Pen Servo Control Board	40	11	29	0	0.0	0.0
#151	LPS	1	2.78	84K05124-019	Module Assembly, Dual Splitter	51	15	36	0	0.0	0.0
#152	LPS	1	20.00	84K05124-009	Module Assembly, Dual Splitter	20	15	5	0	0.0	0.0
#153	LPS	1	5.26	84K05120-009	Module, Splitting Amp	42	23	19	0	0.0	0.0
#154	LPS	1	0.74	83K08175-711	HIM II BTC	170	34	136	1	5.0	5.0
#155	LPS	1	33.33	83K02182-101	FIT Tool Assembly (Test Equipmen	4	1	3	1	15.0	15.0
#156	LPS	1	1.61	83K01154-819	HIM II 8AIC-U	104	42	62	1	5.0	5.0
#157	LPS	1	14.29	83K01154-714	HIM II 4AIC-V07	11	4	7	1	11.0	11.0
#158	LPS	1	2.56	83K01154-702	HIM II 8AIC-N01	50	11	39	1	4.0	4.0
#159	LPS	1	5.88	83K01152-706	HIM II-4AOC-H03	20	3	17	1	8.0	8.0
#160	LPS	1	0.63	83K01148-705	HIM II-GTC, CCMS 1V IN, 15V OUT	182	24	158	1	3.0	3.0

USA United Space Alliance

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Maximo Production Database

MAXIMO

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#161	LPS	1	2.00	83K01146-707	HIM II GDB ID-DID	63	13	50	1	5.0	5.0
#162	LPS	1	12.50	82-27020-001	+/- 15V Power Supply	10	2	8	1	0.5	0.5
#163	LPS	1	3.45	80K60154-1	SCRS Thermal Plotter	40	11	29	1	2.0	2.0
#164	LPS	1	25.00	80K57084-6	RCVS Monitor	11	7	4	0	0.0	0.0
#165	LPS	1	33.33	80K56851-1	Touchscreen Master Console	5	2	3	1	21.0	21.0
#166	LPS	1	14.29	80K56839-1	Console Workstation	10	3	7	0	0.0	0.0
#167	LPS	1	0.36	80K55537-1	FM Analog Transmitter	329	52	277	0	0.0	0.0
#168	LPS	1	1.41	80K54843-2	PCM Digital Transmitter	118	47	71	0	0.0	0.0
#169	LPS	1	7.69	80K54625-5	Vehicle Safing LDB I/F Board	22	9	13	0	0.0	0.0
#170	LPS	1	100.00	80K53472-002	CDBFR Stress Simulator	3	2	1	1	3.5	3.5
#171	LPS	1	100.00	80K53101-8	Mainframe Disk Drive	4	3	1	1	3.0	3.0
#172	LPS	1		79K13564-30	Power Supply Unit	1	1	0	1	6.0	6.0
#173	LPS	1	33.33	79K13514-15	Logic Control Unit	5	2	3	1	0.0	0.0
#174	LPS	1	16.67	79K13500-3	Time Code Translator Card	11	5	6	1	0.0	0.0
#175	LPS	1	6.25	79K13033-3	Memory Driver Card	21	5	16	1	2.5	2.5
#176	LPS	1	100.00	78k01345-009	Memory Card (4k)	1	0	1	1	1.3	1.3
#177	LPS	1		78k00140-040	PFP	1	1	0	1	4.0	4.0
#178	LPS	1	25.00	78K05136-019	Blower Assembly	25	21	4	1	2.0	2.0
#179	LPS	1	20.00	78K02316-019	Control Panel	8	3	5	1	24.0	24.0
#180	LPS	1	1.54	78K01550-020	Summing Amplifier	74	9	65	1	4.7	4.7
#181	LPS	1	9.09	78K01520-009	Splitter Amplifier	17	6	11	0	0.0	0.0
#182	LPS	1	33.33	78K01380-009	Memory Blower Assembly	7	4	3	1	3.5	3.5
#183	LPS	1	3.23	78K00525-019	Splitter/Combiner	51	20	31	1	12.1	12.1
#184	LPS	1	0.78	78K00477-059-D-NS	HIM D Card	150	22	128	1	4.0	4.0
#185	LPS	1	0.25	78K00474-039-A-NS	HIM A Card	576	171	405	1	0.0	0.0
#186	LPS	1	11.11	78K00459-269-W-NS	HIM W Card	18	9	9	1	3.0	3.0
#187	LPS	1	2.70	78K00459-260-W-NS	HIM W Card	57	20	37	1	2.0	2.0
#188	LPS	1	0.87	78K00459-209-N-NS	HIM N Card	188	73	115	1	1.5	1.5
#189	LPS	1	0.88	78K00453-029-S	Master Control Card	157	44	113	0	0.0	0.0
#190	LPS	1	25.00	78K00450-010-NS	Control Card	6	2	4	0	0.0	0.0
#191	LPS	1	2.63	78K00443-080-NS	T/R Module	48	10	38	0	0.0	0.0
#192	LPS	1	20.00	78K00386-010	Blower Assembly	7	2	5	1	0.8	0.8

Top 300 Failures

Responsible Org: LPS
From: 04-01-2003 To: 04-01-2004

Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#193	LPS	1	6.25	78K00376-030	Interrupt Controller Card	22	6	16	1	2.5	2.5
#194	LPS	1	5.88	78K00370-040	Interrupt Error Card	22	5	17	1	2.0	2.0
#195	LPS	1	6.25	78K00352-030	Bus Terminator Card	19	3	16	1	2.5	2.5
#196	LPS	1	5.00	78K00345-019	Self-Test PBIM	56	36	20	1	1.5	1.5
#197	LPS	1	100.00	78K00339-039-T	GPBIM Card	5	4	1	1	3.0	3.0
#198	LPS	1	100.00	78K00336-029	BAC Card	2	1	1	1	5.0	5.0
#199	LPS	1	6.25	78K00328-020	Bus Stack Panel	21	5	16	1	4.0	4.0
#200	LPS	1	6.25	78K00223-160	T/R Board	22	6	16	1	4.0	4.0
#201	LPS	1	7.69	78K00214-503	PCI Chassis - FEP	14	1	13	1	0.0	0.0
#202	LPS	1		78K00169-039	Power Distribution Panel	1	1	0	1	2.0	2.0
#203	LPS	1	0.52	78K00156-029	Power Distribution Panel	196	5	191	1	1.5	1.5
#204	LPS	1	5.56	78K00150-010	Control Logic Board	27	9	18	0	0.0	0.0
#205	LPS	1	0.48	78K00147-030	Display Logic Board	243	36	207	0	0.0	0.0
#206	LPS	1	0.46	78K00144-009	Display Assembly	258	41	217	0	0.0	0.0
#207	LPS	1	25.00	77-03049-001	Power Supply Unit	7	3	4	0	0.0	0.0
#208	LPS	1		77-03034-001	Power DIODE Board	14	14	0	1	0.0	0.0
#209	LPS	1	1.14	76-28041-002	10 X 2 Switch Card	89	1	88	1	0.0	0.0
#210	LPS	1	100.00	720495	Tape Speed Comp Card	2	1	1	1	1.0	1.0
#211	LPS	1		5711C13	Conrac Monitor	11	11	0	1	5.0	5.0
#212	LPS	1	11.11	551-1421-01-001	HS Sync Interface Board	15	6	9	1	6.5	6.5
#213	LPS	1	33.33	551-1365-01-000	WCS Plane	5	2	3	1	2.0	2.0
#214	LPS	1	6.67	551-1338-01-007	Non-Ram Option Plane	49	34	15	1	3.0	3.0
#215	LPS	1	2.63	551-1338-01-006I	RAM Option Plane, Flying L	43	5	38	1	4.0	4.0
#216	LPS	1	12.50	551-1338-01-005N	Non-RAM Option Plane, Flying	10	2	8	1	0.0	0.0
#217	LPS	1	1.06	551-1297-01-007I	4 Port Controller, Flying L	105	11	94	1	4.0	4.0
#218	LPS	1	100.00	551-1297-01-006	4 Port Controller	2	1	1	0	0.0	0.0
#219	LPS	1	1.16	551-1295-01-010I	CPU Plane II, Flying L	95	9	86	1	1.0	1.0
#220	LPS	1	1.12	551-100515-001	Logic Power Supply	116	27	89	1	0.3	0.3
#221	LPS	1	100.00	5370B	COUNTER, FREQUENCY	1	0	1	1	22.0	22.0
#222	LPS	1	4.35	516-2157-01-000	Line Printer Controller	30	7	23	1	10.0	10.0
#223	LPS	1	6.67	516-2139-01-002	SE I/O Drive RX	35	20	15	1	2.0	2.0
#224	LPS	1	10.00	516-1463-01-002	Peripheral Switch	14	4	10	0	0.0	0.0

Top 300 Failures

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Top #	Org	Fail Count	%Fail Rate	Part Number	Description	Total Count	Spare Count	Installed Count	Total Closed	Closed Labor Hours	Avg Labor Hours
#225	LPS	1	0.74	516-1317-02-000	PIT	164	29	135	1	1.0	1.0
#226	LPS	1	0.06	516-100287-002	5V Regulator Strip	2012	428	1584	1	0.0	0.0
#227	LPS	1	0.10	516-100287-001	5V Regulator Strip	1318	270	1048	1	0.0	0.0
#228	LPS	1	12.50	48-8400-01	Pre-Amp	9	1	8	1	0.0	0.0
#229	LPS	1	0.40	460-5829-501B	MIB001 Board	276	26	250	0	0.0	0.0
#230	LPS	1	0.40	460-5637-501V	VID127 Board	276	26	250	1	0.5	0.5
#231	LPS	1	0.40	460-5636-501T	PSB004 Board	275	28	247	1	0.0	0.0
#232	LPS	1	100.00	460-5610-501	DFL006 Board	2	1	1	1	0.5	0.5
#233	LPS	1		460-2142-501	LLF-001 Card	4	4	0	1	1.4	1.4
#234	LPS	1		460-2141-501	VAF055 Board	1	1	0	1	1.8	1.8
#235	LPS	1	1.43	460-1096-A	PSR021 Card	91	21	70	1	6.1	6.1
#236	LPS	1	100.00	460-1095-C	CSD002 Card	2	1	1	0	0.0	0.0
#237	LPS	1	33.33	3496B01A	MVME 167 P2 Card	4	1	3	1	0.0	0.0
#238	LPS	1	4.55	33491A	Printer, C	25	3	22	1	14.0	14.0
#239	LPS	1	16.67	280011-1	+/- 12V Regulator	8	2	6	0	0.0	0.0
#240	LPS	1	12.50	2645A	HP Terminal	13	5	8	1	0.5	0.5
#241	LPS	1	100.00	22303-141A	Model 2150S Tape Drive	3	2	1	1	0.0	0.0
#242	LPS	1	100.00	119-1082-00	Tektronix Power Supply	2	1	1	1	0.0	0.0
#243	LPS	1	16.67	1562GM	Display Monitor, EMS (T)	8	2	6	1	2.0	2.0

APPENDIX A2

INCS PAD B HYPER FARM PARTS LIST

PART OR STOCK NUMBER	DESCRIPTION	LIST OF MATERIALS 65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
2520	CONNECTOR, STRAIN RELIEF								2	2	4
113432	VALVE, SOLENOID 24 VDC								2	2	4
??	DIODE	2									2
1423ORSS3.25-1	STANDOFF, MALE-FEMALE		4		4						8
1492-CB1G-050	CIRCUIT BREAKER	1	4		1				1	1	8
1492-CB1G-150	CIRCUIT BREAKER		1		1						2
1492-CB1H-100	CIRCUIT BREAKER, SLOW TRIP	3	7	1	4	1	1	1			18
1492-CB1H-500	CIRCUIT BREAKER, SLOW TRIP	2	1		2		1	1			7
1492-CB3G-500	CIRCUIT BREAKER								3	3	6
1492-CJ5-10	CENTER JUMPER			5	8	5	2	2			22
1492-CJ5-2	CENTER JUMPER	1	3		3				3	3	13
1492-CJ5-3	CENTER JUMPER	8	22		23		6	6	6	6	77
1492-CJ8-2	CENTER JUMPER				2						2
1492-CJ8-3	CENTER JUMPER				6						6
1492-CJL11-10	CENTER JUMPER		1								1
1492-CJL11-2	CENTER JUMPER		1								1
1492-CJL11-3	CENTER JUMPER		1								1
1492-CJL5	CENTER JUMPER, LINK	2	4	4	11	4	3	3			31
1492-CJL5-2	CENTER JUMPER						3	3			6
1492-CJL8	CENTER JUMPER, LINK	1			3		1	1	3	3	12
1492-CJL8-2	CENTER JUMPER	2									2
1492-CJL8-3	CENTER JUMPER	4									4
1492-CJR5-3	CENTER JUMPER		3		2						5
1492-CJS11-2	CENTER JUMPER								3	3	6
1492-CJS11-3	CENTER JUMPER			6		6			1	1	14
1492-EB10	END BARRIER	7	6	6	6	6	6	6	4	4	51
1492-EB3	TERMINAL BLOCK, END BARRIER	7	21	28	26	28	8	8			126
1492-EB3-Y	END BARRIER	1			1						2
1492-ER35	TERMINAL BLOCK, END ANCHOR	14	23	9	28	9	14	14	8	8	127
1492-GM35	GROUP MARKER	10	5	13	7	13			11	11	70
1492-PP3	PARTITION PLATE								6	6	12
1492-R3	TERMINAL BLOCK, GRY	122	6	360	363	360	60	60	30	30	1391
1492-R3-BL	TERMINAL BLOCK, BLK	13	7								20
1492-R3-RE	TERMINAL BLOCK, RED	5									5
1492-R3-W	TERMINAL BLOCK, WHT	3									3
1492-RG6	TERMINAL BLOCK, GROUND	3	13	38	7	38	1	1	2	2	105
1492-SM5X9H101-200	LABELS			AR	AR	AR					AR
1492-SM5X9H1-10	LABELS	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
1492-SM5X9H1-100	LABELS			AR	AR	AR	AR	AR			AR
1492-SM5X9H11-20	LABELS	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR

PREPARED FOR:
PAD A PEOPLESOFT ORDER

PART OR STOCK NUMBER	DESCRIPTION	LIST OF MATERIALS 65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
1492-SM5X9H21-30	LABELS	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
1492-SM5X9H31-40	LABELS		AR	AR	AR	AR	AR	AR	AR	AR	AR
1492-SM5X9H41-50	LABELS		AR	AR	AR	AR	AR	AR			AR
1492-SM5X9H51-60	LABELS			AR	AR	AR	AR	AR			AR
1492-SM5X9H61-70	LABELS			AR	AR	AR	AR	AR			AR
1492-SM5X9H71-80	LABELS			AR	AR	AR					AR
1492-SM5X9H81-90	LABELS			AR	AR	AR					AR
1492-SM5X9H91-100	LABELS			AR	AR	AR					AR
1492-SM5X9V101-200	LABELS			AR	AR	AR					AR
1492-SM5X9V1-100	LABELS	AR		AR	AR	AR					AR
1492-TC3	PARTITION PLATE	4	4	2	4	2	1	1	1	1	20
1492-TC4-Y	PARTITION PLATE		6	7	4	7	1	1	1	1	28
1492-TPRS	TAPS								4	4	8
1492-W16S	TERMINAL BLOCK, GRY	20	19	19		19	7	7	9	9	109
1492-W16S-RE	TERMINAL BLOCK, RED STD FEED-THRU				21						21
1492-W3	TERMINAL BLOCK, GRY	9	25		9		5	5			53
1492-W3-BL	TERMINAL BLOCK, BLACK STD FEE	8	21	55	88	55	20	20	10	10	287
1492-W3-RE	TERMINAL BLOCK, RED STD FEED-	9	30	89	63	89	19	19	17	17	352
1492-WG4	TERMINAL BOARD	3			8						11
1497-NP2	TRANSFORMER								1	1	2
1734-ACNR15	CNET ADAPTER, POINT I/O		1		1		1	1	1	1	6
1734-BNCP	CONNECTOR BNC				4						4
1734-FPD	FIELD PWR DISTR MODULE				1		1	1	1	1	5
1734-IB4	DIGITAL DC INPUT MODULE						1	1	1	1	4
1734-IE2V	ANALOG I/O MODULE				3		1	1	1	1	7
1734-OB2EP	I/O PROTECTED OUTPUT MODULE						2	2	2	2	8
1734-OW2	DIGITAL CONTACT OUTPUT MODULE				1						1
1734-OX2	DIGITAL CONTACT OUTPUT MODULE		1		1		1	1	1	1	6
1734-TBS	TERMINAL BASE				7		5	5			17
1756-1F6I	ANALOG I/O MODULE			4		4					8
1756-A10	CHASSIS, 10 SLOT		1								1
1756-A17	CHASSIS, 17 SLOT			1	1	1					3
1756-A7	CHASSIS, 7 SLOT	3					1	1			5
1756-BNCP	CONNECTOR BNC	4									4
1756-CNBR	COMM MODULE CONTROLNET	5	2	1	3	1	5	5			22
1756-DNB	COMM MODULE DEVICENET		1		1						2
1756-ENET	COMM MODULE ETHERNET	1	1		1						3
1756-IB16	DIGITAL DC INPUT MODULE	1	1	2	3	2	1	1			11

		LIST OF MATERIALS									
PART OR STOCK NUMBER	DESCRIPTION	65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
1756-IF16	ANALOG I/O MODULE		1	2	5	2	1	1			12
1756-IR6I	ANOLOG I/O MODULE - RTD			1		1					2
1756-L55M12	CONTROLLOGIX PROCESSOR	2	1	1	1	1					6
1756-N2	COVER PLATE	6	2		3		2	2			15
1756-OB16	DIGITAL DC OUTPUT MODULE	1			6						7
1756-OB8EI	DIGITAL DC OUTPUT MODULE		1	5		5	1	1			13
1756-OF8	ANALOG I/O MODULE	1		1		1					3
1756-PB72	POWER SUPPLY						1	1			2
1756-PB75	POWER SUPPLY	3	1	1	1	1					7
1756-TBS6H	TERMINAL BLOCK, REMOVABLE			7	14	7					28
1756-TBSH	TERMINAL BLOCK, REMOVABLE	3		8	2	8					21
1757-SRM	SRM MODULE	2									2
1786-BNCP	CONNECTOR, BNC								2	2	4
1786-TBYR	TAP, CONTROLNET	2					1	1			4
1786-TPRS	TAP, CONTROLNET				4						4
1786-TPS	TAP, CONTROLNET	8									8
1786-TPYR	TAP, CONTROLNET		10	2		2					14
1786-XT	TERMIINATOR, CONTROLNET	6	10	2	4	2	1	1	4	4	34
1794-AENT	CNET ADAPTER, FLEX I/O	1	1		1						3
1794-IE4XOE2	DIGITAL DC I/O COMB MODULE	1	1		1						3
1794-OW8	DIGITAL DC RELAY MODULE	1	1		1						3
1794-TB3	TERMINAL BASE	2	2		2						6
199-DRI	RAIL, DIN - 27"	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
20AD027A3AYNACNN	POWERFLEX 70								1	1	2
3439001846953	SOLDER			AR		AR					
700-HA32A2A24	RELAY HOLDER	5	5		5						15
79K03438A4C11	TRANSDUCER, PRESS 0-75 PSIA								1	1	2
79K03438U5C05	TRANSDUCER, PRESS 0-5 PSID								1	1	2
79K04637	CABLE SUBASSEMBLY (6#20)						5	5			10
79K06114	CABLE SUBASSEMBLY (2#20)						8	8			16
79K24851-DET EK	REF DETAIL								1	1	2
79K24851-DET EL	REF DETAIL								1	1	2
90K10010-1	ENCLOSURE, DISTRIBUTOR ASSEMBLY			1		1					2
90K10010-2	ENCLOSURE, DISTRIBUTOR ASSEMBLY				1						1
90K10010-3	ENCLOSURE, DISTRIBUTOR ASSEMBLY		1								1
90K10010-4	ENCLOSURE, DISTRIBUTOR ASSEMBLY	1									1

PREPARED FOR:
PAD A PEOPLESOFT ORDER

		LIST OF MATERIALS									
PART OR STOCK NUMBER	DESCRIPTION	65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
90K10100	HARNESS ASSEMBLY 7(7#16)			60		60	3	3			126
90K10101	HARNESS ASSEMBLY 60(60#16)				6						6
90K10200-2		1									1
90K10200-3		1									1
90K10200-4		1									1
90K10200-5		1									1
90K10200-6	REF DES PLATE	AR									AR
90K10200-7	REF DES PLATE	AR									AR
90K10200-8		1									1
90K10201-2			1								1
90K10201-3			1								1
90K10201-4			1								1
90K10201-5	REF DES PLATE		AR								AR
90K10201-6	REF DES PLATE		AR								AR
90K10201-7	SENSOR PLATE		1								1
90K10201-8	CONNECTOR PLATE		1								1
90K10202-2	BACK PLANE			1							1
90K10202-3	PLATE, GROUND			1							1
90K10202-4	REF DES PLATE			AR							AR
90K10202-5	REF DES PLATE			AR							AR
90K10202-6	SENSOR PLATE			1							1
90K10202-7	CONNECTOR PLATE			1							1
90K10203-2	BACK PLANE				1						1
90K10203-3	PLATE, GROUND				1						1
90K10203-4	REF DES PLATE				AR						AR
90K10203-5	REF DES PLATE				AR						AR
90K10203-6	SENSOR PLATE				1						1
90K10203-7	CONNECTOR PLATE				1						1
90K10204-2	BACK PLANE					1					1
90K10204-3	PLATE, GROUND					1					1
90K10204-4	REF DES PLATE					AR					AR
90K10204-5	REF DES PLATE					AR					AR
90K10204-6	SENSOR PLATE					1					1
90K10204-7	CONNECTOR PLATE					1					1
90K10205-2	BACK PLANE						1				1
90K10205-3	REF DES PLATE						AR				AR
90K10205-4	PLATE, GROUND						1				1
90K10206-2	BACK PLANE							1			1
90K10206-3	REF DES PLATE							AR			AR
90K10206-4	PLATE, GROUND							1			1

PREPARED FOR:
PAD A PEOPLESOFT ORDER

PART OR STOCK NUMBER	DESCRIPTION	65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
		LIST OF MATERIALS									
90K10207-2	BACK PLANE										
90K10207-3	REF DES PLATE								1		1
90K10208-2	BACK PLANE								AR		AR
90K10208-3	REF DES PLATE									1	1
90K10600	PAD B SAFING SOFTWARE	1								AR	AR
90K10602	CCB22 FUEL FARMS SOFTWARE				1						1
90K12050-11027	CABLE ASSEMBLY	1									1
90K12050-11028	CABLE ASSEMBLY	1									1
913B-30-B	SENSOR, CURRENT DC		4		4						1
920-1519	JACKET, BANANA - BLK			1		1					8
AN960-516	WASHER, FLAT	4	4	4	4	4	4	4			2
AN960-C10	WASHER, FLAT										28
AS-100F-24/DRL	POWER SUPPLY								52	52	104
C1LG6	COVER, WIRE DUCT -PANDUIT	AR	AR	AR	AR	AR	AR	AR	1	1	2
C2LG6	COVER, WIRE DUCT -PANDUIT	AR	AR	AR	AR	AR					AR
F1X2LG6	WIRE DUCT, PANDUIT								AR	AR	AR
F1X3LG6	WIRE DUCT, PANDUIT	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
F2X3LG6	WIRE DUCT, PANDUIT	AR	AR	AR	AR	AR					AR
KC103-4	SEAL RING										0
KC103-6	SEAL RING								2	2	4
KC112C4	ADAPTER BOSS TO TUBE								6	6	12
KC116C6-6	NIPPLE, TUBE TO PIPE								2	2	4
M700-HN125	RELAY	5	5		5				6	6	12
MS15795-801	WASHER, FLAT		4								15
MS15795-808	WASHER, FLAT	103	90		128		27	27			4
MS15795-810	WASHER, FLAT				4						375
MS16878 / 17BHE9	WIRE , WHITE	AR	AR	AR	AR	AR	AR	AR			4
MS16878 / 17BKE0	WIRE , GREEN	AR	AR		AR				AR	AR	AR
MS16878 / 17BKE9	WIRE , WHITE	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
MS16997-52	SCREW, CAP										AR
MS21042-5	NUT, SELF LOCK	2	2	2	2	2	2	2	2	2	4
MS24140-02	RELAY										14
MS27183-10	WASHER, FLAT										0
MS3106R-14S-6S	CONNECTOR, TRANSDUCER								8	8	16
MS35206-241	SCREW	10	10	10	10	10	6	6	2	2	4
MS35206-272	SCREW										62
MS35206-287	SCREW, MACH								3	3	6
MS35308-338	SCREW, HEX	2	2	2	2	2	2	2	4	4	8
MS35333-41	WASHER, INT TOOTH	2	2	2	2	2	2	2			14
MS35338-138	WASHER, LOCK	103	90	113	128	113	27	27	27	27	655

PREPARED FOR:
PAD A PEOPLESOFT ORDER

PART OR STOCK NUMBER	DESCRIPTION	LIST OF MATERIALS 65002 90K10200-1 QTY	65301 90K10201-1 QTY	65302 90K10202-1 QTY	65401 90K10203-1 QTY	65402 90K10204-1 QTY	7867A1 90K10205-1 QTY	7857A1 90K10206-1 QTY	7864A1 90K10207-1 QTY	7874A1 90K10208-1 QTY	EACH TOTALS
MS35338-139	WASHER, LOCK		4		4						8
MS35338-42	WASHER, LOCK	10	10	10	10	10	6	6			62
MS35338-44	WASHER, LOCK								8	8	16
MS35649-2252	NUT, HEX								4	4	8
MS35650-304	NUT				2						2
MS5086 / 2-8-01	WIRE , GREEN #8	AR							AR	AR	AR
MS51957-30	SCREW			10		10					20
MS51957-65	SCREW								2	2	4
MS51957-80	SCREW		4		4						8
MS51958-63	SCREW, PAN HEAD MACHINE	103	88	113	126	113	27	27	49	49	695
MS51958-65	SCREW, PAN HEAD	2	2		2						6
MS51968-5	NUT,HEX	2	2	2	2	2	2	2			14
MS9956-24	PACKING								2	2	4
OCM-CTN-13-P-D-ST-24V-MM	FIBER MODULE, MULTIMODE		3		3						6
OCM-CTN-85-P-D-ST-ACV-MM	FIBER MODULE, MULTIMODE		1		1						2
P-601	ADHESIVE, PLIOBOND	1	1	1	1	1	1	1	1	1	9
S-320-27	DC POWER SUPPLY	1	1		1						3
XXXX	STANDOFF, ROUND	2	2	2	2	2	2	2			14
									TOAL INCS PATHFINDER PARTS		
											7159

PREPARED FOR:
PAD A PEOPLESOFT ORDER

APPENDIX A3

WEBPCASS, INCS PATHFINDER FAILURE REPORT

Back | ADAM Cross Search Page | KSC IPR/PR/DR Search Page

There were no associated KSC CAAR Reports found.
There were no associated JSC CAR Reports found.
There were no associated MSFC PAC Reports found.
There were no associated SIMS Images found.

Report#: I-V6-416284 796980-1	**Initiation Date:** 2004-08-18	**Current EICN:** CR3-7003 **Old EICN:** CR3-7003	**EICN History:** 1) CR3-7003 2) PADB-2689 3) CR3-7003	**Status/Closure Date:** Open
Deferred Date:		**Deferred to Event:**		**Out of Family:**

Page Number 1

Report Date: 2004-08-18	**Reported By:** DONALD G SIMMONS	**Criticality HW/Funct:** 3/	**STS/Elem/Effectivity:** 000-L-CR3
Part/Prog Name:	**Part/Prog #:**	**Serial/Rev #:**	**Work Area Code/Loc/Zone:** CR-3//
NHA Part #:		**Detected During:** C2000	**Engineering Group:** GEN
Process Escape: No		**OMRS Affected:**	
Datacode Element: -	**System:** CM-CHECKOUT, CONTROL, AND MONITORING SYS		**Cause:** -
Disposition: -	**When Discovered/ Attributable Source:** -	**Reliability/ Responsible Org Loc:** -	**How Malfunction:** -

Problem Description:
Item 1
INCS PLC FAILURE IS NOT REPORTED TO THE FEP BY THE IBOX IN THE PATHFINDER SOFTWARE RELEASE

Material Review Required:		**Inflight Anomaly:**	
Related Reports:			
Item:	**Type:**	**Report:**	**Title:**

Problem Disposition:

Supporting Reports:
Click on link to view supporting data:

APPENDIX B

Additional Information and photos come from the following web pages:

KSC NASA Web Page. www.ksc.nasa.gov

NASA Web Page. www.nasa.gov

JSC NASA Web Page www.jsc.nasa.gov

Shuttle Program Web Page www.sp.jsc.nasa.gov

USA Internal Web Page usago1.ksc.nasa.gov

APPENDIX C

PERMISSION TO CONDUCT RESEARCH